PRODUCT ENGINEERING

For Engineers and Executives Responsible for Product Creation, Design and Improvement

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MARCH, 1932 VOL. 3, NO. 3

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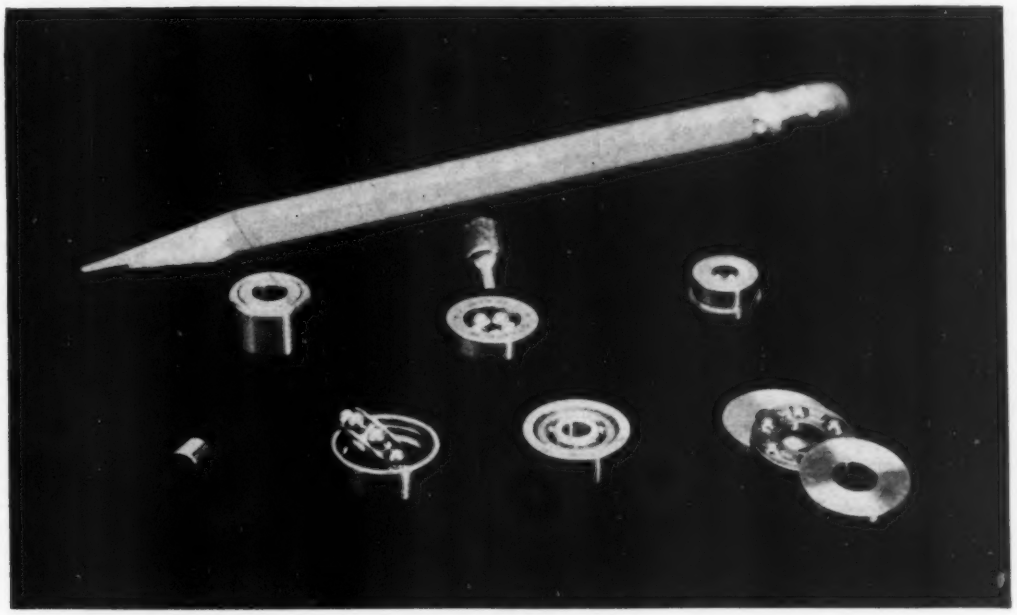


Some of these small highly sensitive ball bearings are complete in themselves, while others are designed for use with a shaft forming the inner raceway

Low Torque Applications of Ball Bearings

By D. E. BATESOLE

Assistant Engineering Manager, Norma-Hoffmann Bearings Corporation

Scales, relays, self-synchronizing motors and gyroscope gimbal supports are only a few examples wherein the torque on the rotating element is at a minimum. Obviously for such applications the starting and running friction within the bearings must be extremely small. In this article certain types of such ball bearings and mountings are discussed

WHERE SPEEDS run high and loads unusually heavy, there anti-friction bearings find their normal field. And many words have been published describing their proper mountings and applications. There is, however, still another field, particularly for ball bearings, where these conditions do not exist—where the low friction qualities of the bearings are of primary importance. I refer to such applications as scales, relays, self-synchronizing motors, gyroscope gimbal supports, film developing idler rolls, and other devices where the sensitivity of the bearing and low rotational friction are vital to the success of the mechanism. In all of these uses, only a low torque is available to cause rotation, and this low torque is usually insufficient to overcome any great amount of starting or running friction within the bearing.

Modern ball and roller bearings have so little starting friction as compared to the average sleeve bearing that they have become popularly known as "anti-friction" bearings. However, it is impossible to build either type of bearing without certain parts sliding, rather than rolling, with respect to each other, and so we find that every "anti-friction" bearing, when rotating, has a certain amount, however small, of sliding friction. In the low torque applications mentioned above, the loads imposed are usually extremely light and small ball bearings are therefore used. Our discussion will therefore be confined to the

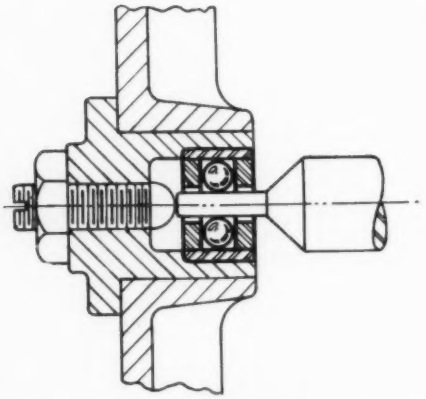


Fig. 1—This type of bearing is suitable for the lightest radial loads and greatest sensitivity

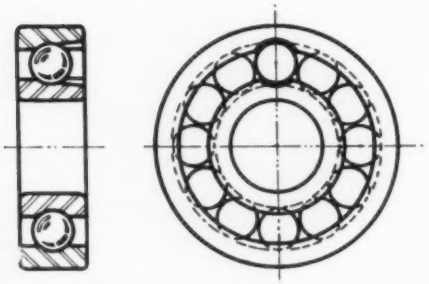


Fig. 2—This "closed type" ball bearing without ball retainer is capable of carrying greater radial loads

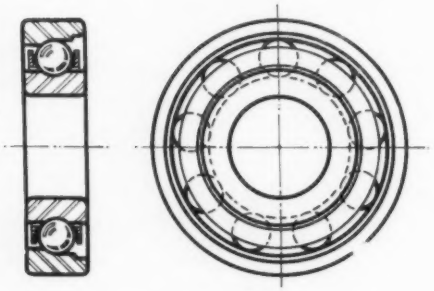


Fig. 3—The "magneto type" ball bearing can be separated quickly and easily for inspection and cleaning; a one-piece retainer can be used

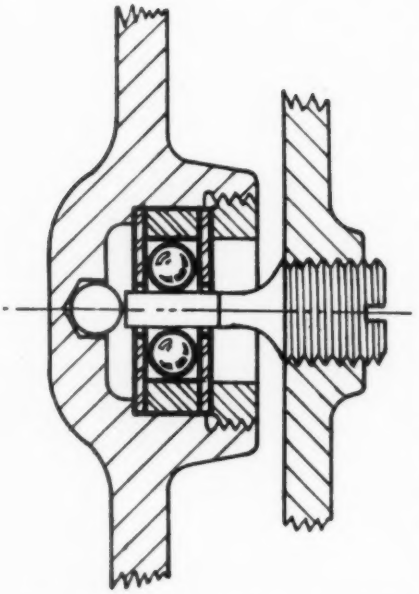


Fig. 4—Typical mounting of a ball bearing with cylindrical raceways, used on a weighing scale

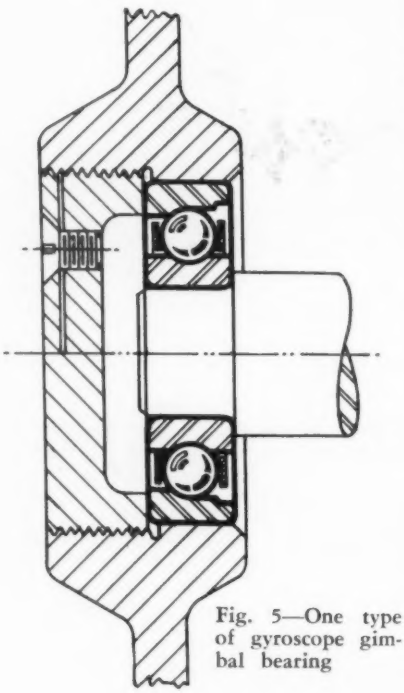


Fig. 5—One type of gyroscope gimbal bearing

design requirements of these small ball bearings and the features of their mounting essential to obtain the best results.

The form of ball bearing most desirable for the carrying of very light radial loads with the greatest sensitivity may be said to be that shown in Fig. 1. The bearing has straight cylindrical surfaces normal to the plane of rotation of the balls. The diameter of the inner raceway is small and the balls are relatively large. The inner member of the bearing is the shaft (or a stationary pin). The bearing has no cage or ball retainer but side plates or washers are used to confine the balls to their path of rotation. This type of bearing is suitable for use on the cylinders of weighing scales and for similar applications.

It will be apparent immediately, in the type of bearing just mentioned, that the area of contact between the ball and the cylindrical raceway is unusually small. Naturally, if a load of any great magnitude is imposed on such a bearing the pressure at the point of contact will be excessive and "Brinelling" or permanent indentation of the raceways will occur. Even though the intended loading of the bearing may be well within its capacity, rough handling during shipment may result in a shock load sufficient to indent the raceways. Where these conditions are likely to occur, it is then desirable to increase the contact area between ball and raceway by rotating the balls in grooved paths or races as in Fig. 2. Bearings with grooved raceways will of course take care of end thrust and endwise shaft location.

The illustration in Fig. 2 is that of the "closed type" ball bearing without a ball retainer. Obviously the balls in this bearing must be assembled through filling slots which are ground to a point closely but not quite approaching the bottom of the grooved raceways. This design of bearing is very good except for the fact that the rings may possibly be distorted and become out of round in mounting on account of the thin ring section at the filling slots, unless unusual care is taken. To avoid this possibility a ball retainer may be used to space the balls, so that filling slots are no longer necessary. Naturally this retainer must hold the balls lightly and not restrict their free movement. The sliding friction formerly experienced between each pair of balls is now replaced with friction between ball and retainer.

Another popular type of bearing for sensitive applications is that shown in Fig. 3. This is the open or separable type (sometimes referred to as the "magneto" type because of its almost universal use on magneto armature shafts). The open type bearing can be quickly and easily separated into its component parts for cleaning and inspection. Furthermore, a one-piece retainer can be used since the outer ring may be assembled from the side after the retainers and balls are in place on the inner ring. In the retainer illustrated, the balls are lightly held in the recessed pockets of the side flanges with contact close to the axis of rotation of the balls, where the relative surface movement is small.

A typical mounting of a ball bearing with cylindrical raceways for a weighing scale is shown in Fig. 4. This illustrates only one end of the cylinder shaft, but the two ends may be identical. The cylinder is carried on stationary pins which form the inner raceways, these pins being threaded so that they may be fastened to the scale frame. Endwise location of the cylinder is taken care of by means of a stationary steel ball at each end, this ball contacting with the hardened and carefully ground

end of the pin. By means of the threads accurate adjustment can be made so that the cylinder will rotate freely but with no appreciable endwise movement.

Some of the most exacting requirements for freely rotating ball bearings are found in connection with the gimbal support mounting for small gyroscopes. In most cases the same bearings are used on the gyroscope rotor as in the gimbals. The rotor may have a speed in excess of 20,000 r.p.m. whereas the support bearings may turn only a small fraction of a degree. Furthermore, in some of the gyroscope applications the unit may be subjected to considerable shock load, as for example in torpedoes where they are used to maintain the true direction of the projectile. These torpedoes when striking the water may decelerate rapidly with the result that the gyro bearings are subjected to a severe shock. Obviously cylindrical raceway ball bearings are not satisfactory under such conditions because any indentation of the raceways would restrict the free movement of the bearing.

One type of gyroscope gimbal bearing is that illustrated in Fig. 5. Open-type bearings accurately adjusted endwise are used, the same bearings also functioning to support the high speed rotor itself. It is essential that all parts used with the bearings be most accurately made to insure alignment of the bearings and to prevent cramping of the balls at any part of the raceways during rotation. A new and interesting ball bearing application for gyroscopes is that used in the recently developed "artificial horizon" for aircraft, which depends upon a high-speed rotor with sensitive gimbal mountings for its proper functioning.

Another use for freely rotating ball bearings is in small self-synchronizing motors for indicating and recording purposes. The rotors of such motors turn through a very small arc only and are used to reproduce the corresponding movement of a similar unit located perhaps miles away. For example these electric indicating devices may be used to register water levels at various points along a stream or they may register the gage readings of distant power plants. A small movement of the rotor of the actuating unit must be duplicated by a similar movement of the rotor of the indicating motor. When the two units are in close synchronism or "correspondence" the torque is unusually low, but it increases as the two units vary in relative rotor position. It is obvious therefore that the bearings of the synchronous motor must be exceptionally free from sticking, if a true reading is to result. In certain gun control applications, the "correspondence" must be within one degree of arc, a specification which demands a most sensitive bearing application.

A typical mounting for ball bearings on self synchronizing motors is shown in Fig. 6. Open-type ball bearings are used, with a very light spring adjustment at the right hand bearing. The spring is of a corrugated construction, and it bears against the outer ring of the bearing with just enough pressure to keep the balls in their proper position. Some manufacturers employ closed-type ball bearings, and more of them prefer the open-type bearing for applications of this kind on account of the ease with which it can be cleaned and inspected.

An interesting and rather unusual problem involving sensitive ball bearings is found in the motion picture industry in the apparatus for developing the film. Idler rolls support the strip of film lightly as it passes through the developing and fixing solution and also as it dries. The idler rolls are turned by the contact of the film only, and obviously any sticking of the bearings will cause the film to become scratched and worthless. Stainless steel bearings are needed to resist the corrosive action of the various solutions, but through special processes of grinding and lapping it is now possible to provide smooth and freely rotating bearings of this material. The idler roll design shown in Fig. 7 illustrates the usual form of mounting. It will be observed that no attempt is made to protect the bearings, since they usually operate in a submerged position. Closed-type ball bearings either with or without retainers are used.

The matter of lubrication for sensitive bearing applications is very important. The lubricant used must be able to retain its original quality and consistency through the extremes of temperatures encountered, and it must not gum or cake even after it has been in service for a considerable time. The most approved practice is to use only a few drops of a light grade of the best mineral oil at the time of assembly. This amount is sufficient to coat all of the surfaces and prevent rust. It will likewise reduce the friction between the rubbing parts. In cases where there are un-

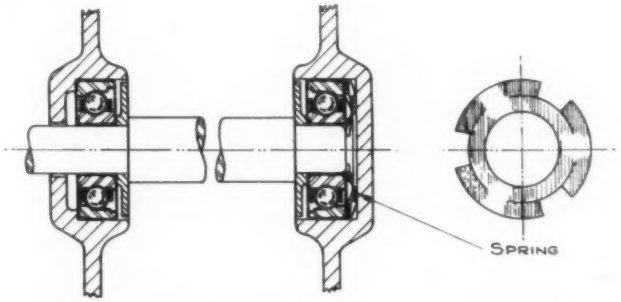


Fig. 6—Open-type ball bearing used on self synchronizing motors

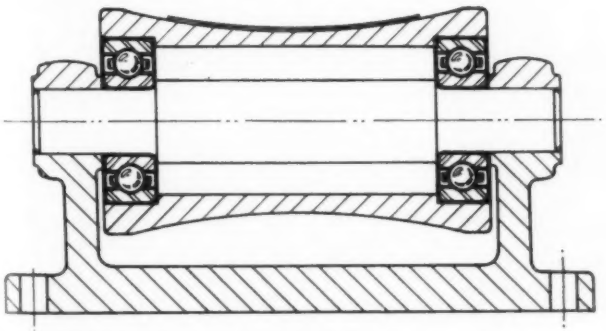


Fig. 7—Idler rollers used for developing and drying motion picture films must have highly sensitive bearings that are also corrosion resistant

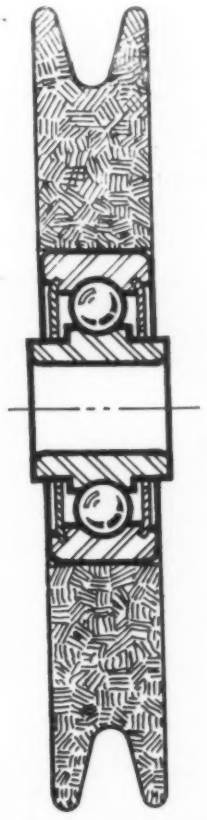


Fig. 8—Steel side plates form an inexpensive but efficient protection

usual extremes of temperature, it is of course necessary to vary the above practice and select a lubricant which will not cause any sticking of the bearing during rotation.

Cleanliness in connection with low torque bearing applications cannot be too strongly emphasized. The smallest particle of foreign matter in the path of the ball will cause the bearing to bind. Care should therefore be taken to see that the bearings and other parts are thoroughly clean before mounting, and the housings should be protected so that dirt cannot enter them after the unit is in service. The bearings should not be taken from their original wrappings until the moment of assembly. If it is desired to remove the original flushing oil or grease from them, they should be washed in clean light oil or kerosene, not gasoline, as this frequently leaves a deposit or film on the bearing surfaces. The bearings should not be blown out with compressed air. Open-type bearings, if dirty can be disassembled and the individual parts wiped clean. Closed-type bearings if dirty or sticking should be returned to the manufacturer for cleaning and examination.

In designing a suitable protective means for the bearing housings some form of "labyrinth" protection should be used, with rotating parts in fairly close contact with the stationary members. Felts and other forms of flexible packing cannot be used as they offer too much resistance to free rotation of the shaft. To meet the demand for an inexpensive but efficient protection, ball bearings are now obtainable with steel side plates as illustrated in Fig. 8. This shows an idler pulley mounted on a single ball bearing having side plates projecting over the recessed portions of the inner ring, to form a labyrinth.

A few years ago the very small size of ball bearings were not produced commercially. However, the increasing popularity of anti-friction bearings for instruments, motors, relays and other small devices has resulted in the large scale production of unusually small bearings. As an indication of the demand for very small ball bearings, it is pointed out that complete ball bearings of the closed type but without retainers are now obtainable to fit a shaft of $\frac{1}{8}$ in. in diameter and with an outside diameter of only $\frac{3}{8}$ in. The bearing contains a full row of $\frac{1}{16}$-in. diameter balls. Small ball bearings are also now obtainable made from a variety of corrosion resisting materials such as stainless steel, Monel metal, bronze, and similar alloys. They may be used, however, only where the loads to be carried are not excessive, as their carrying capacity is limited.

In the foregoing pages I have attempted to outline briefly the requirements for low torque bearing applications. In general it is found that each individual design has special characteristics which will dictate the type of bearing to use and the kind of mounting necessary.

Graphical Method for Solving Higher Degree Equations

By E. N. Kemler
Gulf Production Laboratories

SEVERAL recent problems appearing in *Product Engineering* have their solution as roots of cubic or higher degree equations. The cut and try methods or Horner's method are usually the easiest method of getting a solution. There is, however, a graphical method apparently little known to engineers that is quite ingenious as well as useful in many cases. This method is given in "Practical Mathematical Analysis" by H. Von Saden, and can be applied to an equation of any degree and in general will be accurate within a few per cent.

The method can best be illustrated by taking an example:

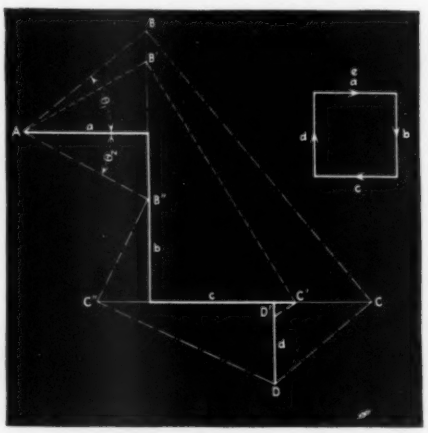
$$3x^3 + 4x^2 - 3x - 2 = 0$$

Or. in general:

$$ax^3 \pm bx^2 \pm cx \pm d = 0$$

The coefficients of the X terms are laid off along lines, such that the line for each coefficient makes an angle of 90° with each preceding line. The directions of the lines are best found by associating each coefficient with the side of a square, as indicated in the figure. The lines go in a clockwise direction for positive coefficients and in a counter clockwise direction if the sign is negative. In laying out the coefficients the diagram is made as shown in the figure. The directions of c and d are counter clockwise because their signs are negative.

The roots are then found in the following manner: From A draw a line at any angle, to the extension of length b. Where this line cuts the extended line at B' draw a perpendicular line and extend it till it cuts the extended line c at C'. From this point, draw a line perpendicular to B′C′ to where it cuts line d. By changing line AB a position will be reached where the line CD' will cut d at D. One of the roots is then given by $X = \tan \theta$. Another root can be found by drawing a line A-B'' below a, and, following the same procedure, giving $X_2 = \tan \theta_2$. Once one root is found the equation can be divided by it and reduced one degree. In case all roots are positive or negative, only the upper or lower line can be drawn. If one pair of roots are imaginary only the real root can be found.

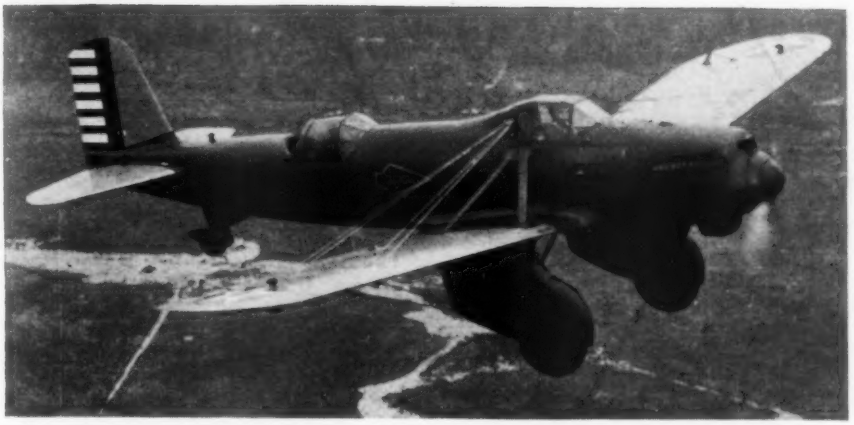


In the small square, each successive line, *a, b, c, d,* has a clockwise line direction to indicate a positive coefficient. In the solution of the given example, *c* and *d* have a counter clockwise direction, as they are negative coefficients

In the previous example the two solutions given in the figure are $x_1 = 0.834$ and $x_2 = -0.473$.

This method might appear to be hard to use but if the lines, a, b, c, d, etc., are laid out on one sheet of paper and a transparent sheet of cross section paper laid over it, the roots may easily be found by pivoting the cross section paper about A. As lines on the cross section paper make 90 deg. angles, one need only to follow the lines to an intersection and then follow the perpendicular, repeating the process until the solution is found.

The MONTH in PRODUCT DEVELOPMENT



CURTISS XA-8 attack plane, an all-metal low-wing wire-braced monoplane designed for U. S. Army. Automatic slots and controllable flaps in its wings and its direct-connected Curtiss V-1570C 600-hp. engine give it top speed of 197 m.p.h. with usual landing speed

Official Photograph, U. S. Army Air Corps.

CRUDE OIL motors of 1,100 hp. to be used on LZ-129, world's largest lighter-than-air ship, now building at Luftschiffbau . . . Dr. Duerr, designer, takes issue with Dr. Arnstein's putting the Akron's engines within the hull to decrease air resistance . . . will consequently place engines in gondolas as usual . . . Though air resistance will be increased and servicing made more difficult, he will achieve greater hull space, possibly greater safety and reliability . . . His 750-ft. ship will make 80 m.p.h. in transatlantic service.

Martin completes new design high-speed "mystery" bomber . . . uses retractable landing gear and twin Hornet engines to attain speeds above 180 m.p.h., as compared with conventional 110-140 . . . Bomber is low-wing type with pilot sandwiched between fore and aft bomb gunners.

Curtiss plans seven distinct new types of planes this year . . . Continues the trend toward all-metal construction . . . On the same subject, Maj. C. W. Howard, chief engineer of the Materiel Division, Army Air Corps, in his annual report, "We are through the transition stage from wood to metal" . . . He believes also that tire and wheel streamlining steps up 150-m.p.h. ships 3 to 6 m.p.h.

Oddest of current plane designs is the wingless modified rotor type now being assembled by its inventor at Roosevelt Field . . . Twin conical rotors supplant each wing . . . are driven by a motor apiece; a third drives the propeller . . . Inventor expects greater lift and landing speed . . . believes his conical design with small pockets will avoid air blasts that wrecked previous rotor types.

Two more light German planes, designed after glider principles, weigh 570 and 770 lb., cost $700 . . . Wing spreads 29 and 32 ft. . . . Designed to popularize flying.

Aircraft Engines

Richard Beckman develops 1,300-hp. engine weighing but 975 lb. . . . Air-cooled cylinders radiate from barrel-type crankcase in conventional way . . . Employs no carburetor and only one valve atop cylinder head for exhaust gases . . . Gasoline is forced into cylinders from fuel pump at 75 lb. per sq.in. . . . is mixed with air from three superchargers just before entering combustion chamber . . . Fuel is spray-nozzle vaporized with air at 20 lb. per sq.in. . . . Moving parts reduced 90 per cent, total parts 80 per cent.

Present transport planes are noisy . . . partly from exhaust, partly from propeller hum . . . Now geared engines turning big high-pitched propellers at low speeds halve "prop" hum . . . Chief Engineer Lockwood, Eastern Air Transport, devises double-size exhaust manifold with inbuilt stationary screw . . . Forces exhaust gases to spin about and travel 48 ft. before release . . . cuts engine noise 70 per cent without loss of power.

Office Equipment

Electromatic electrically operated typewriters now available with carriages 36 in. long . . . include carriage return and shift for capitals by power . . . Basket shift design permits rigid construction of both carriage frame and ways.

Adco bookkeeping machine desk mounts standard bookkeeping machine at center of two drawer sections . . . Right-hand drawer includes lever-operated swiveling and lifting file . . . permits operator to raise and swivel it to any desired position . . . Another model has wheel-type rotating 5,500-card file set in top.

Remington Rand engineers intro-

TANDEM DRIVE of the Riddell road maintainer. The gear case is the frame that carries the set of four rear driving wheels on each side. Gears are nickel steel running in oil; all roller bearings. The unit replaces a track layer effectively

duce pressed-steel tiltable file spacers . . . run on rollers at side of drawer . . . Tilt in a V either forward or backward with spacer bottom as axis . . . Telescoping section permits lengthening as necessary . . . Tension springs at each side hold rollers on rollways . . . Pressed-in space at center allows for designation cards.

Lever-type staplers a pain-in-the-palm for 40 years . . . Now comes Kling-Tite . . . adapts compression spring principle of automatic center punch . . . Instead of pounding stapler lever, you press on it . . . build up pressure behind compression spring . . . It trips—and there you are . . . Capacity up to 40 sheets of paper possible . . . Rubber feet protect desk surface.

New hand-operated saddle-back stitcher has 12-in. gap.

Pam-O-Graph phonograph records speeches, radio reports, what have you? . . . Broadcast-type 2-button microphone does recording . . . Sound level shown by neon-tube visual volume indicator . . . Cabinet follows standard designs with controls simplified as much as possible.

Teleregister adapted as stock market quotation registering device . . . User dials, on desk dial, number of stock whose price he wants . . . Figures on small teleregister immediately show opening, high, low and last quotations for whichever of the 1286 New York Stock Exchange stocks he has dialed.

Industrial

German engineers devise conveyor-type motor-operated lignite excavator . . . removes about 1,100 cu.yd. per hour.

Automobile freight cars need frequent reflooring (100,000 a year at $100 a car) because of heavy spikes used with conventional blocking . . . Evans Products substitutes a built-in slotted track and shackles clamping to T-bolts . . . Makes nailing unnecessary, permits car to be used for other purposes.

Bendix engineers adapt aviation propeller to prosaic job of industrial air cooling . . . Fan is laminated northern birch . . . Monel-metal-covered to provide corrosion resistance . . . 2-piece flanged hub, copied after airplane prop hubs, attaches to the driving motor . . . centered by radial arms in propeller protecting ring that doubles as attaching medium . . . Similar arrangements, with larger props, have been used for mine ventilation . . . One prop proved ineffective, so they were ganged on one hub . . . Inquisitive engineer, looking makeshift over, decides to insert blades in same radial plane about hub . . . tries it . . . Air capacity up over 50 per cent.

Barret Haentjens combines centrifugal-pump suction-line strainer, primer, and check valve in single casting . . . with automatic air eductor for good measure . . . for manual or automatic operation . . . Incoming water strained by strainer set at sharp angle to triple surface . . . then passes through check valve at peak of inverted U . . . finally out past series of traps educting air automatically . . . Priming chamber, float operated, at center of U.

Explosion

Puffed wheat and rice are standard breakfast foods . . . U. S. Bureau of Mines adopts their principle of manufacture—explosion in a steam gun . . . substitutes explosion for crushing in separations of minerals in ore . . . Underlying idea is that ores are honeycomb structures . . . may be filled with water . . . water heated to steam . . . Bang! . . . Metals, crumbled, may be screened out . . . Rock, in pieces large enough for concrete aggregate, remains . . . Process extracts 60-90 per cent of metal.

FIRST INSTALLATION of diesel in lighter-than-air craft just made by Goodyear. Germany's super-Zeppelin, twice as large as the *Akron*, will have 1,100-hp. crude oil engines, housed in gondolas as is this one. Both indicate trend to avoid conventional engines and the 40 per cent of air accidents they cause

Latest adaptation of gunpowder to something other than war is Temple Gun . . . employs small cartridges in rivet-type gun . . . drives studs, clamps nipples on cable, drills holes, kills steers . . . even drives studs under water into tank under pressure . . . Larger cartridges arranged with heads carrying breakpins . . . permit powder burning pressure to build up before stud or drill is ejected . . . gives maximum effect for any cartridge size . . . Gun neither kicks nor "pops."

General

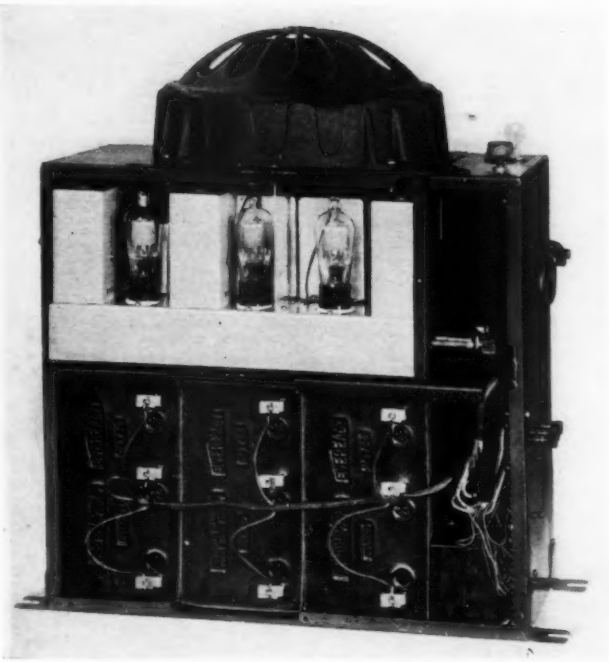
Screen cloth sales involve odd quantities . . . Measuring and cutting annoy dealers . . . Handling and waste cut into their profits . . . American Wire Fabrics engineers devise tape measure rolled in screening . . . Dealers cut off tape and all . . . use tape to tie up rolled screen cloth . . . save time and trouble.

Small—less than $5,000—house field offers commercial possibilities . . . Designers busily at work devising houses to combine practicability with advantages of factory fabrication, speedy erection . . . American Rolling Mill engineers use walls of corrugated sheet steel . . . enclose and insulate them with fibrous materials attached with structural adhesives . . . Walls of room length, story height, to be fabricated in mills . . . perhaps with plumbing and electrical conduits in place . . . will be welded together on job in 2 or 3 days.

Ferro-Enamel Corp. devises steel-frame-and-wall dwelling . . . Exterior walls, roof, some floors, paneling in both bathroom and kitchen finished in porcelain enamel . . . Design permits easy insulation of exterior walls . . . rapid erection by welding.

Simon Lake patents conical submarine escape buoy . . . attaches to superstructure of sub-surface craft . . . Buoy large enough to hold two or three men . . . contains cable, telephone wires, air hose . . . Can be released and floated to surface to mark position . . . or can convey crew, a few at a time, to surface if need arises.

Coblentz pie delivery truck body has six doors on each side . . . open directly into pie chambers . . . Construction adds about half to capacity



EARLY police radio sets were bulky and unreliable. Here is new Stromberg-Carlson complete in 20x15½ x9-in. steel box with loud speaker and potentiometer on top to shorten wiring. To operate, it is connected to car frame and screen wire antenna. Sets of this type may soon be adapted for two- or three wave-length pleasure automobile use

. . . permits 12 pie chambers, each with 16 trays . . . Pay load, 4628 small pies . . . Haskelite PlyMetl forms paneling and doors of this 2,000-lb. body, 14 ft. 4 in. x 5 ft. 2 in. x 5 ft. 2½ in.

Electrical

"Bell boxes," companions to telephones, to be almost a half smaller . . . Western Electric engineers reduced size of gongs and condenser, arranged equipment more compactly, deleted space formerly allowed for relay and switchhook sometimes used . . . But rearranging caused steel base and cover to interfere magnetically with ringer operation . . . Redesign produced phenol-plastic cover and brass base, both non-magnetic . . . Gleaming cover more durable, less likely to scratch.

Conventional microphones cannot follow speaker's perambulations, hence of small use in public address systems . . . New "mike," 1 in. in diameter, weighs 1½ oz., equipped with 30-ft. flexible cord . . . clipped to lapel, stays closer than a brother . . . Thin aluminum cone-shaped diaphragm of sufficient stiffness to cause it to vibrate throughout desired frequency range . . . edge-supported on series of 0.004-in. impregnated paper rings slightly separated to provide resilient support, slight damping to reduce resonance . . . Unlike usual mike in which diaphragm forms one electrode . . . cone is insulated from granular carbon by phenol varnish coating . . . Ring electrodes, separated by ceramic current-path-defining barrier, enclose and energize granules, which practically fill space to cut noise from vibration in moving . . . Rubber insulating housing eliminates disturbing noises created by rubbing against clothing . . . Necessary jack and plug in coat pocket.

Possibly an unwelcome trend is development of loud-speaker public address device for planes . . . twice as powerful as anything thus far built.

New GE flexible rubber electric heating unit . . . about ½ in. wide by a foot long . . . designed to heat aviator's clothing for high-altitude flying . . . Should find more prosaic uses.

Parts

Chapman engineers, remembering previous plug cock difficulties, design a valve in which plug is first lifted by a threaded stem, then a grease seal established between plug and body and the plug rotated by a lug.

Lunkenheimer has a rotor valve lubricated from a well above the rotor . . . Valve is essentially a straight-bored body and cylindrical rotor with oil grooves in such a position that lubricant is used only when valve is turning . . . Rotor and stem are separate to provide better seating.

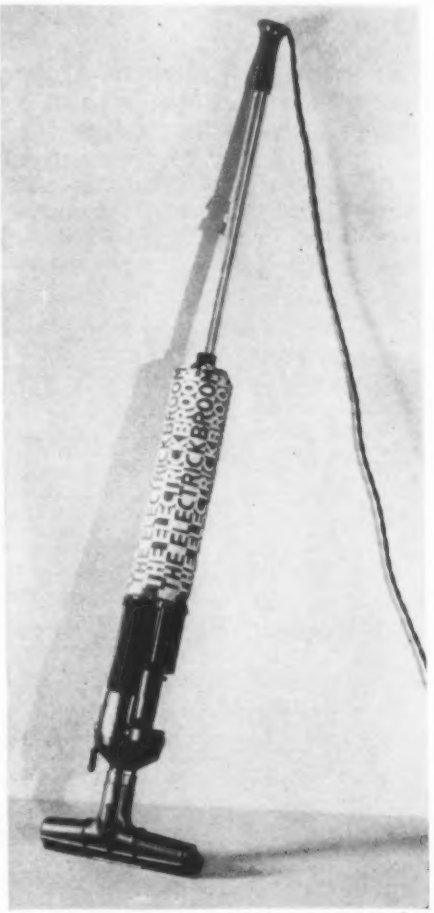
Condor weld, belt joining method for making "endless" belts, permits the two cut ends of a belt to be interlapped, set with rubber rivets and "welded" electrically.

Gates Rubber Co. now forms lug-strap holders, box, tail and Draper pickers of rubber-bonded cotton fabric . . . compounded to eliminate "bounce."

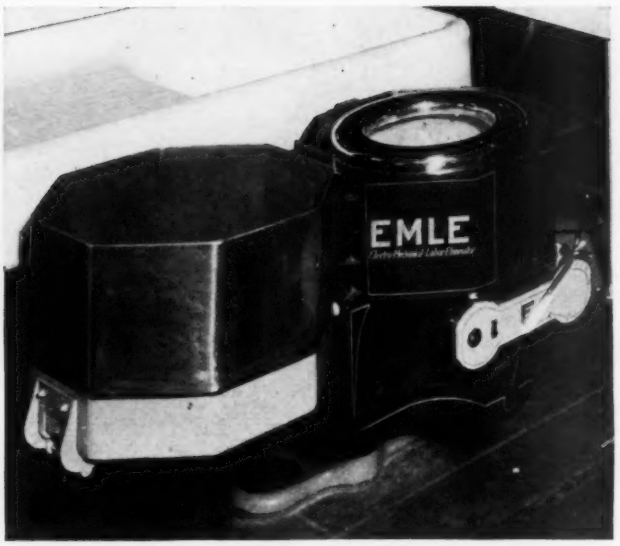
Control

New Barber-Colman Hygrostat provides inexpensive electrical humidifying apparatus control . . . essentially an automatic two-way switch, operated by changes in length of wood cylinder as it reacts to variations in atmospheric moisture content . . . Molded phenolic resin forms base and cover . . . All metal parts are rustproofed . . . Wood cylinder shows variations of less than 4 per cent . . . indicates them by pointer on scale.

Minute lateral adjustment of beam heads provided in new all-metal paperless warp beam for silk and rayon warps . . . avoids wood and paper and consequent distortion . . . Uses an outside threaded block sliding in keyway in drum to provide preliminary adjustment in flange . . . fastened by setscrew . . . then threads provide 2½ in. of close lateral adjustment and motion.



MOLDED PLASTICS and rubber form major parts of "Electrickbroom," combination broom, dust mop, and vacuum cleaner, weighing less than 4 lb. and retailing for less than $15. Handle is of automatic switch type. Filter and molded plastic dirt collecter are incorporated

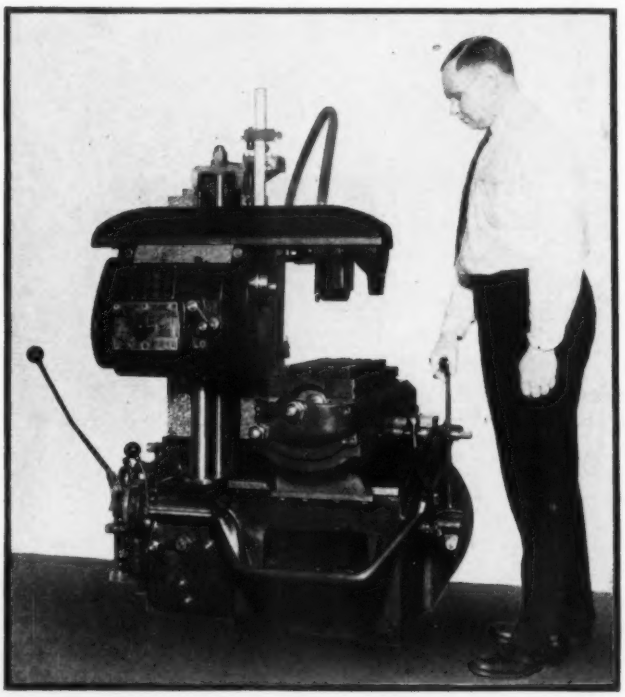


EMLE, electro-mechanical labor eliminator, capable of washing, drying and ironing clothes, washing, drying and polishing dishes, toasting bread, running a lathe, drying hair, extracting juices, beating and mixing drinks, exercising and massaging, and dozens of other jobs—yet it folds up under the sink

Goodrich tires will now match automobile colors . . . "Colorweld" rubber will do the trick.

Cadillac experimenting with 10-lb. tire pressure . . . May supplant shock absorbers . . . would permit spokeless wheels.

Shell Petrogas, new motor fuel, first refrigerates, then burns . . . is held under pressure at atmospheric temperature in liquid form . . . passes first a high regulator and series of expansion coils . . . There it becomes a gas . . . picks up heat enough to keep body at—25 deg. F.



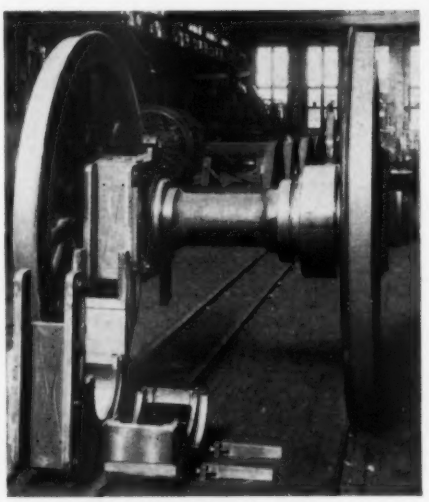
CENTRALIZED control levers permit changes of automatic feed while cut is in progress in this Kemp-S-Mill hydraulic production milling machine for small parts . . . thus provides flexibility comparable to hand miller . . . Selector lever permits feeding of headstock or table, or holding both in given position while cutter rotates . . . High speeds for carbide tools . . . Hydraulic clutch in feed circuit builds up feed to meet cutting resistance

Home Entertainment

Many engineers produce radio sets to use soundbox and amplifier of conventional phonograph . . . Now comes Operadio — just the opposite . . . Electric phonograph motor and turntable and sensitive electromagnetic pickup housed in leatherette carrying case with record storage in its top . . . Whole unit adaptable to any electric radio or power amplifier by provision for connection to either high- or low-impedance pickups.

New long-playing records obsolete much phonograph equipment . . . But engineers of a dozen companies produce devices for converting motor speed of old 78½-r.p.m. motors to new 33⅓ . . . RCA Victor universal replacement motor board on market . . . uses the pickup, volume control and other parts from old board . . . incorporates speed-reducing mechanism for intechangeability . . . Most others are simply speed-reducing mechanisms to provide two desired speeds.

SKF journal bearings of the type just applied to main driving axles of a New York Central Hudson-type locomotive. Present journal boxes were adapted for the spherical roller bearings



Automotive

Ford's new deluxe bus includes window in lower front door panel to aid driver in avoiding stops in mud puddles . . . or hitting small children with opening door.

Curtain-type steel doors for garages are familiar . . . but now comes curtain-type door winding at side . . . devised by engineers of Acme Partition Co. . . . composed of 16-gage interlocking steel slats supported from overhead track by ball bearing sheaves . . . Spans up to 200 ft. wide by 30 ft. high can be obtained with either hand or motor operation.

Refrigeration

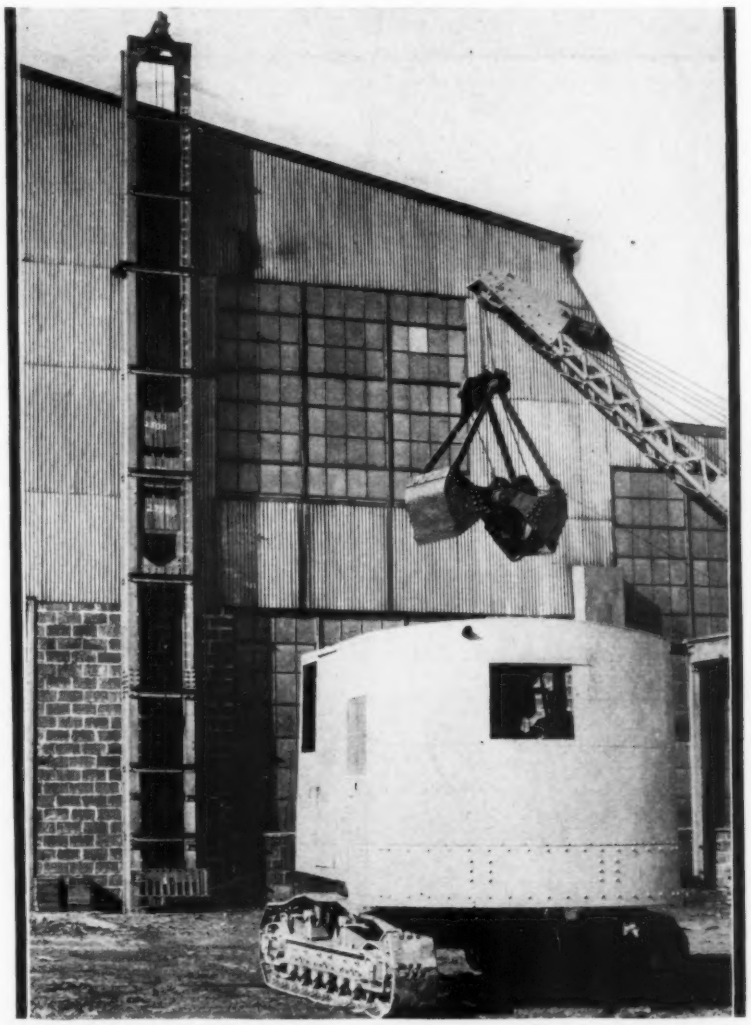
Forced air circulation is used by General Electric Engineers in just announced "Conditioned Air Refrigeration" display cases and the like . . . maintains high humidities by comparatively high evaporator temperature and minimum temperature difference between evaporator and cabinet air . . . All air in cabinet forced at least five times a minute through series of tunnels formed by wet evaporator plates . . . Food odors absorbed by water on plates . . . carried to drain . . . Arrangement permits evaporator only one-third former size . . . can be placed anywhere desired with proper baffling . . . Injector in evaporator keeps refrigerant in circulation.

Frigidaire air conditioners include one design to supplant usual radiator . . . Cabinets steel lacquered to represent burl walnut . . . contain only essential fans and coils . . . Compressor in separate cabinet.

Engagement Pressure for Brakes on Hoists

Unit pressures of engagement for band clutches and brakes, as given in the equations presented by the author in his article in the February number of *Product Engineering,* do not apply to band brakes used on hoists where the load is dropped the greater part of the distance, caught at the lower end of travel, and brought to a standstill with a hard application of the brake. In this article are formulas and calculations for such conditions

By A. C. RASMUSSEN
Mechanical Engineer, Indianapolis, Ind.



MACHINE for testing excavator equipment and for the purpose of checking engine, engine accessories, and clutch performance. The drop weights total 7,500 lb. and a maximum drop of about 40 ft. is available

IN BAND-TYPE brakes and clutches, the initial tension and the final tension in the band are very much increased when the operator makes extra effort to apply sufficient braking action. Consequently the unit pressures of engagement are increased considerably above those normally existing.

Although it is impossible to determine these abnormal pressures accurately, the following analysis will be of some value to enable one to obtain an approximation of what they might be. In this analysis, it is first assumed that the load falls freely through a certain distance h_1 and is then brought to a standstill while traveling through the distance s. In actual practice, it is not usual to allow the load to drop freely, and the brakes are applied sufficiently to keep the falling load reasonably within control. Additional formulas are given to take this condition into consideration.

Let W = load in pounds.
g = acceleration of gravity.
v = velocity in ft. per sec. acquired by load at time of applying the brake.
h_1 = distance in feet that load is dropped.
s = distance in feet that load travels during the time that brake is applied and load is brought to a standstill.
t = time in seconds the brake is applied.

The total energy absorbed by the brake in bringing the load to a stop in t seconds is E.

$$E = \frac{W v^2}{2g} + \frac{W vt}{2} \qquad (1)$$

Where a single line is used, the average tension in the hoist line required to stop the load is L. This average tension acts through the time t and at an average velocity of $v/2$. The energy of this retarding force

must be equal to the energy of the moving load.

$$E = \frac{L\,vt}{2} \qquad (2)$$

$$= \frac{W\,v^2}{2g} + \frac{W\,vt}{2}$$

$$L = W\left(\frac{v}{g\,t} + 1\right) \qquad (3)$$

It is difficult to determine the velocity v actually acquired by the load in dropping the distance h_1 and it is also difficult to determine the time t required to stop the load. At the best it would only be possible to estimate the time that the load drops and the time required to stop the load with the brake. However, one can obtain a fairly close idea as to the point in the total drop where the brake is applied. The distance $h_1 + s$ is the total drop, of which h_1 is the distance covered during the free fall and s is the distance covered during the time that the brakes are applied.

But $v^2 = 2\,gh_1$

and $t = \dfrac{2\,s}{v}$

Substituting these values in equation 3, the following equation in terms of h_1 and s is obtained:

$$L = W\left(\frac{h_1}{s} + 1\right) \qquad (4)$$

Let

h = total height, $= (h_1 + s)$

Then,

$$L = W\frac{h}{s} \qquad (5)$$

This formula is readily verified by equating the work done by the retarding force L to the work produced by the load in traveling downward the distance h, or

$$Ls = Wh$$

or,

$$L = W\,\frac{h}{s}$$

Equation 5 gives the average line pull required to stop the load. Since the line pull at the time that the load is brought to a standstill is equal to the load W, therefore the maximum line pull is obtained from the relation:

$$\text{Average} = \frac{Max. + Min.}{2}$$

or, Max. = 2 Average — Min.

therefore, $L_{max} = 2\,\dfrac{h}{s}\,W - W$

or $L_{max} = W\left(\dfrac{2h}{s} - 1\right) \qquad (6)$

The foregoing equations are based on the load falling freely through the distance h_1. However, since the brake is partially applied when falling through this distance, the velocity of the load, therefore, does not reach that of a free falling body. A greater time is required for the full descent, and $L_{max.}$ does not become as great as is given by equation 6.

In Equations 1 and 2, $\dfrac{v\,t}{2} = s$

Therefore, $L\,s = W\left(\dfrac{v^2}{2g} + s\right) \qquad (7)$

Since the load does not fall with the acceleration of gravity on account of the retardation of the brake, let a represent the resultant downward acceleration. Then the velocity v in equation 7 is that due to a, or

$$v^2 = 2\,ah_1 \qquad (8)$$

The time t for the complete descent is known. This total time includes t_1, the time of the descent through the distance h_1 and t_2, the time of descent through the distance s.

$$h_1 = \frac{1}{2}\,at_1^2$$

or $t_1^2 = \dfrac{2\,h_1}{a}$

$$t_1 = \sqrt{\frac{2\,h_1}{a}} \qquad (9)$$

$$t_2 = \frac{2\,s}{v}$$

$$= \frac{2\,s}{\sqrt{2\,ah_1}} \qquad (10)$$

$$t = \sqrt{\frac{2\,h_1}{a}} + \frac{2\,s}{\sqrt{2\,ah_1}}$$

$$t = \frac{2\,h}{\sqrt{2\,ah_1}} \qquad (11)$$

Transposing Equation 11,

$$a = \frac{4\,h^2}{2\,h_1\,t^2} \qquad (12)$$

Substituting this value of a in Equation 8

$$v^2 = \frac{4\,h^2}{t^2} \qquad (13)$$

Substituting value of v^2 in Equation 7,

$$L\,s = W\left(\frac{2\,h^2}{gt^2} + s\right)$$

From which

$$L = W\left(\frac{2\,h^2}{gst^2} + 1\right) \qquad (14)$$

$$L_{max} = 2W\left(\frac{2\,h^2}{gst^2} + 1\right) - W$$

$$L_{max} = W\left(\frac{4\,h^2}{gst^2} + 1\right) \qquad (15)$$

The foregoing value of $L_{max.}$ is used, rather than the value W, as the line-pull on the hoisting drum. In Equation 15, the quantity within the parenthesis shows the relation of the maximum line-pull to the static line-pull W.

Values of maximum allowable pressures are found by obtaining the rim force resulting from this line-pull, this resultant rim force being then used in the various formulas which have been developed in the foregoing text to find the maximum tension and maximum unit pressure.

Manufacturers of friction lining material produce many different kinds and grades. No attempt can be made here to give the recommended limits for unit pressures for the different materials. However, the following figures show approximately the loads which have been successfully used for several types of material and may be considered as limiting pressures of engagement per square inch.

1. Molded and compressed friction blocks . . . . 200 lb. per sq.in.
2. Molded band friction lining. . . 150 lb. per sq.in.
3. Woven and compressed friction lining. . . . . 100 lb. per sq.in.
4. Folded and compressed friction lining. . . . 100 lb. per sq.in.

The foregoing figures are for construction equipment where the space which is available limits the size of the clutches and brakes, and more frequent replacements are permitted. For more permanent installations about 50 per cent of these loads should be used.

Tests have been made on a special machine used for testing brake lining under actual service conditions. This machine consists of vertical guides in which a heavy weight is hoisted and lowered by a wire rope line from an excavator of the full-revolving shovel type, this excavator being a standard machine placed in position for test purposes. It contains the hoist drum on which the brake lining is tested. The weight can be lifted in definite time cycles, lowered at different rates of speed and caught with the brake at different points.

This same device is used to give a "lift test" to all excavating machines that are produced at the factory where these tests on friction lining were made. This "lift test" exposes weak engines, faulty ignition, improper carburetor adjustments, improper gear train assembly, clutch troubles and many other cases of mal-functioning.

As an example for showing the method of computing $L_{max.}$, data obtained on certain tests using the special machine described above, will be used. The test weight weighed 7,500 lb. The pitch diameter of the rope on the drum was 16 in. and the brake drum diameter was 24 in. Therefore the resultant rim force R was:

$$7{,}500 \times \frac{16}{24} = 5{,}000 \text{ lb.}$$

Total height of hoist, h .... 30 ft.
Free fall height, h_1..... 20 ft.
"Brake applied" distance, s 10 ft.
Total time of descent, t .. 6 secs.

Width of lining..... b = 3 in.
Brake drum diam..... b = 24 in.
Angle of wrap..... 330 deg.
k = 330/360
u = 0.55

From the tables appearing in the previous article for the resulting value of uk, 0.50, we get:

$$Y = 1.045$$
$$T_1 = R\ Y = 1.045\ R$$
$$T_1 = 1.045 \times 5000$$
$$= 5225$$

For max. unit pressure p_1 we have:

$$p_1 = \frac{2\ T_1}{bd}$$
$$p_1 = \frac{2 \times 5225}{3 \times 24}$$
$$p_1 = 145 \text{ lb. per sq.in.}$$

Assuming that the weight W falls freely for twenty feet and is caught up by the brake and brought to a standstill in the next ten feet, the maximum line pull is found from Equation 6, as

$$L_{max} = W\left(\frac{2\ h}{s} - 1\right)$$
$$= W\left(\frac{2 \times 30}{10} - 1\right)$$
$$= 5\ W = 37{,}500 \text{ lb.}$$
$$p_1 = 725 \text{ lb. per sq.in.}$$

However, the brake was partially applied during the drop of twenty feet and the total time of descent was six seconds. The resultant line pull for these conditions is found from Equation 15.

$$L_{max} = W\left(\frac{4\ h^2}{gst^2} + 1\right)$$
$$= W\left(\frac{4 \times 900}{32 \times 10 \times 36} + 1\right)$$
$$= W\left(\frac{10}{32} + 1\right)$$
$$= 1.3125\ W = 9{,}844 \text{ lb.}$$
$$p_1 = 190 \text{ lb. per sq.in.}$$

This last result indicates that the stresses do increase considerably over the stresses found from static load conditions. However, one must be careful to get the actual data. For instance, certain operators would not stop the weight in ten feet, but would apply the brake very hard, stop the movement in five feet and then ease the weight the rest of the way. The total drop is thereby reduced 5 ft., and the time is reduced by 1 sec.

In this case $h = 25$ ft., $s = 5$ ft. and $t = 5$ sec.

$$L_{max} = W\left(\frac{4 \times 625}{32 \times 5 \times 25} + 1\right)$$
$$= W\ (0.625 + 1)$$
$$= 1.625\ W = 12{,}188 \text{ lb.}$$
$$p_1 = 236 \text{ lb. per sq.in.}$$

On the other hand, another operator will apply the brake earlier, still dropping the load the total distance in six seconds.

$h = 30$ ft., $s = 15$ ft. and $t = 6$ sec.

$$L_{max} = W\left(\frac{4 \times 900}{32 \times 15 \times 36} + 1\right)$$
$$= 1.208\ W = 9{,}060 \text{ lb.}$$
$$p_1 = 175 \text{ lb. per sq.in.}$$

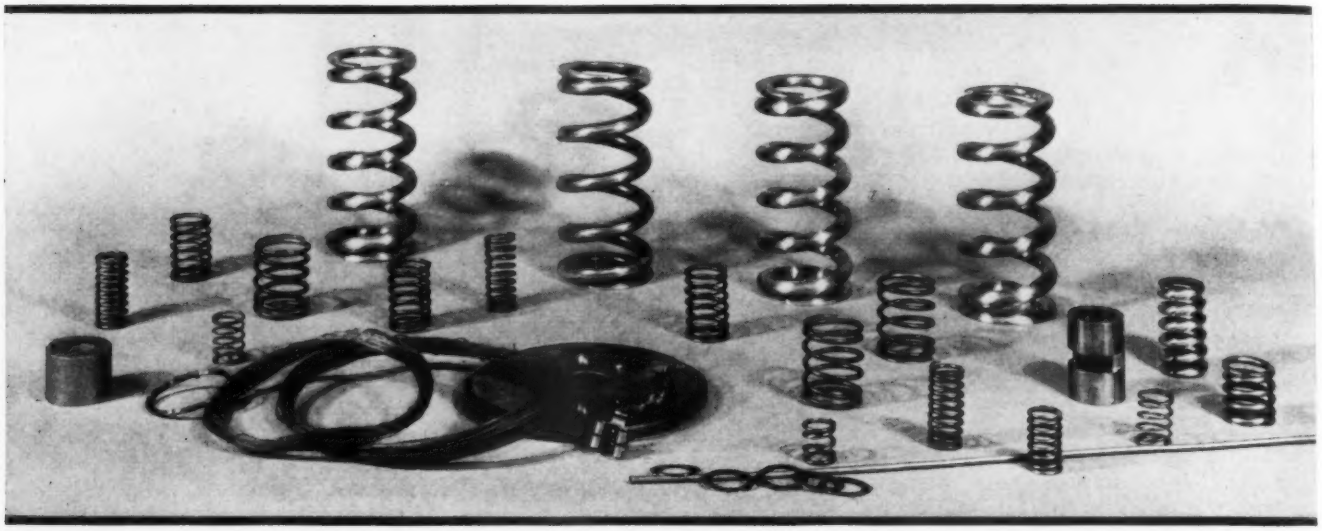
In another case the operator may apply the brake at the end of ten feet of drop, allowing the load to drop to the bottom in six seconds.

$h = 30$ ft., $s = 20$ ft. and $t = 6$ sec.

$$L_{max} = W\left(\frac{4 \times 900}{32 \times 20 \times 36} + 1\right)$$
$$= 1.156\ W = 8{,}670 \text{ lb.}$$
$$p_1 = 168 \text{ lb. per sq.in.}$$

From the foregoing examples, it is quite evident that the unit pressures are increased quite considerably if the load is dropped and then caught by the brake during the last portion of the travel.

When the brakes become hot through constant use the strength of the binder in the material is weakened, and then with the high pressures obtained by careless application of the brakes, the friction material is quickly ruined. When such severe conditions of heat and unit pressures are encountered, it is most advisable to get in direct touch with the engineering departments of the friction material manufacturers as they alone can make proper recommendations for the particular materials which they manufacture.



Springs of beryllium-copper alloys have been stressed 25,000,000 times without apparent fatigue while standard phosphor spring bronze failed after 400,000 compressions

Wrought Beryllium-Copper for Electrical Parts and Springs

Interview with Dr. K. G. Frank
Consulting Engineer,
Siemens & Halske, A.G.

ADDITIONS of about 2.5 per cent of beryllium to copper produce alloys which are approximately six times as hard and five times as strong in tension as the original copper. These alloys, which Siemens-Halske engineers have called Be-bronze, (See article on metal standards *PE*—October, 1931) have just recently been produced in wrought form in Germany. Be-bronze can be drawn, rolled, pressed and stamped, and its properties may be modified by heat-treatment. The heat-treated be-bronze has a high elasticity and a high resistance to fatigue, and has been used for highly stressed springs. Leaf springs made of this alloy have been subjected to repeated stress as many as 25,000,000 times without sign of fatigue while similar springs of phosphor bronze failed after an average of 400,000 vibrations. Spiral springs of be-bronze have withstood 3,000,000 compressions; springs of standard spring steel have failed after 2,000,000. Be-bronze is especially adaptable for springs to replace bronze springs in applications where electrical conductivity as well as high resistance to continuous alternate stress is a factor such as motor brush-holder springs, and springs for automatic telephones.

Beryllium is not a new metal, but up to eight years ago it sold only in minute quantities at $5,000 per pound. It is one of the most common occurring metals, yet it has been only through persistent research that economic methods of extraction have been developed. And the price has been dropped until beryllium alloys can be marketed at a price that makes them commercially available. Beryllium is 30 per cent lighter than aluminum, has a higher melting point, 2,322 deg. F., higher electrical conductivity, and is so hard that it will scratch glass. But its immediately most valuable property is that it will alloy with copper, nickel, cobalt, aluminum and steel to form alloy metals of remarkable new properties. Small quantities of beryllium with the common metals produce alloys of great hardness and strength.

Be-bronze with 2.5 per cent of beryllium is easier to roll than most bronzes. It has already been produced in the form of wire, sheet and tubing. It can be die-forged at between 1,110 and 1,290 deg. F. Various heat-treatments have been applied to the alloy. One heat-treated wrought alloy showed a tensile strength of 82,000 lb. per sq.in., and elongation of 21 per cent. A 3-per cent alloy, after heat-treatment, showed a tensile strength of 172,000 lb. per sq.in., and elongation of 2 per cent. It is even possible by suitable heat-treatment to attain a hardness of 400 Brinell in these alloys. Thus are offered possibilities as a construction material where hard wearing surfaces together with high corrosion resistance are needed. It has been applied with great success to the manufacture of motor and generator commutator segments, giving greater conductivity than copper and much longer life because of its hard-wearing surface. While exact data are not available on the corrosion resistance of be-bronze, it is stated that it is more resistant to corrosion than ordinary compositions of bronze, and should be of value for chemical processing machinery parts.

A year ago we made some prophesies about beryllium and received wide comment. Last month we announced that a beryllium-copper high-strength, hard casting alloy had been put on the market. So great was the response and so many the requests for more information that we are now glad to be able to announce further developments in wrought metals of new physical and electrical characteristics. A new series of alloys have come into being for engineering and construction, and further developments in stronger light metals are ahead—Watch for new things in beryllium "hardmetals"

Journal Friction with Boundary Lubrication

By G. F. NORDENHOLT and HERBERT CHASE

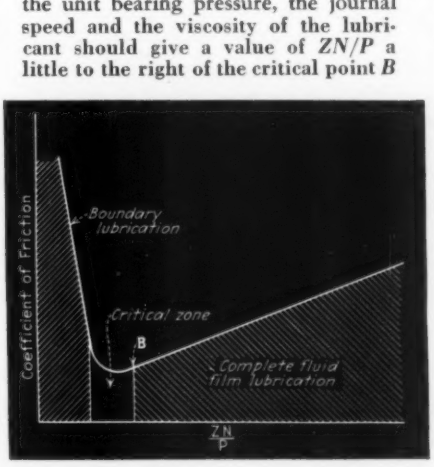
Perfection, it has been said, is measured by the closeness of the margin between success and failure. Bearings and their lubricating means give minimum friction losses when the combination of lubricant viscosity, unit bearing pressure and speed is such that an unstable condition bordering on failure is approached. A few of the more simple lubricating devices are illustrated and described

IN ANALYZING the lubrication condition for any bearing, one must go back to the fundamentals enunciated by Hersey, who established the theory that for geometrically similar bearings, the coefficient of friction depended upon the value of the expression ZN/P, where Z is the absolute viscosity of the lubricant in centipoises, N is the revolutions per minute of the journal, and P is the unit bearing pressure on the projected area, that is, the total load divided by the length of the bearing times its diameter. On the basis of experiments, a curve such as shown in Fig. 1 was obtained.

In the range of complete fluid film lubrication as indicated on the curve, oil is being fed to the bearing as fast as it leaks out. However, for a given speed and lubricant viscosity, as the unit bearing pressure for a given viscosity increases, the value of ZN/P decreases. At first, the coefficient of friction decreases proportionately, as shown by the straight-line curve in the range of complete fluid film lubrication. However, a point is soon reached, as designated by B, where the curve changes its direction. It is generally considered that at this point we have the beginning of discontinuous film lubrication. It is the point where film rupture begins. As the unit bearing pressure increases further, the value of ZN/P decreasing, metallic contacts between the journal and bearing surfaces takes place, with a consequent rapid increase in the coefficient of friction. Seizure soon occurs.

The ideal plain bearing would be one in which the unit bearing load, viscosity of the lubricant, and speed of the journal were such that a minimum coefficient of friction resulted. This is not, however, a practical possibility, because it would require operating the bearing in the critical zone where any decrease in viscosity of the lubricant would result in seizure. It is evident that even a momentary heating of the oil film would result in an appreciable decrease in viscosity, thereby causing seizure.

Fig. 1—For minimum friction losses, the unit bearing pressure, the journal speed and the viscosity of the lubricant should give a value of ZN/P a little to the right of the critical point B



A discontinuous film, or boundary lubrication as it is frequently called, may occur momentarily during the starting period in almost any plain bearing. Until the speed of rotation has been brought up sufficiently high to give a high enough value to the factor ZN/P, the bearing will be operating in the region to the left of the point B indicated on the curve in Fig. 1. All bearings must be large enough so that the bearing will not be scored before the lubricating film has been established, this calling for a relatively low valve of P. It is evident, therefore, that for a given viscosity of oil, lubrication conditions in a high-speed bearing might be improved in some cases if a complete lubricating film is not maintained. Such a condition would result in an increase in the load per sq.in. on the lubricating film, thus decreasing the value of ZN/P, with a corresponding decrease in the coefficient of friction. Thus, a generously proportioned bearing will have a low unit bearing pressure at the beginning of rotation when the speed is slow. As the speed increases a point may be reached where complete fluid film lubrication is established. However, with an insufficient supply of lubricating oil, and the end leakage from the bearing increasing with speed, the complete film is soon broken, resulting in boundary lubrication and a correspondingly higher load per sq.in. on the lubricated portion of the bearing.

Because boundary lubrication results in the bearing operating in or near the critical zone where a complete breakdown of the lubricating film is possible, as a result of momentary overheating causing a decrease in viscosity, Z, metal-to-metal contact is likely to take place. Therefore, it is especially important to select a bearing metal that will not cut the shaft and which will itself suffer a mini-

mum of injury from such a contact.

The simplest illustration of boundary lubrication is a plain bearing with merely an oil hole, usually equipped with a cover to keep out dirt and grit. Such bearings are usually oiled when the machine starts up, and after that at infrequent intervals. At the time of oiling, a complete lubricating film is established, but end leakage soon results in boundary lubrication. The remaining oil will stay in the bearing because of its natural resistance to expulsion, this property of the lubricant being generally termed "lubricity" or oiliness.

Wick Feeds

Where a more nearly continuous supply of lubricant is required, some form of lubricator is employed, utilizing a variety of materials capable of absorbing oil and feeding it slowly to the bearings. In the accompanying figure is shown one form of such a lubricator wherein capillary attraction is called upon to feed the oil through a so-called "syphon" type of wick feed. As can be seen from the illustration, the rate of feed diminishes as the oil level in the cup goes down. For a given oil, the shape of the reservoir and the number of strands of wicking are the two governing factors controlling the variable rate of feed. The rate of feed can also be varied by providing a throttle or throat member, which compresses the wicking at some point between the reservoir and the bearing. Furthermore, the rate of feed is also influenced by the length of wick below the level of the oil in the reservoir.

Sometimes, in order to keep a uniform oil level in the reservoir, thus maintaining a constant rate of lubricant feed, the lubricator is designed as shown in Fig. 3. The inverted bottle, with the mouth of the bottle at the level of the oil, provides a uniform depth of oil in the reservoir.

These types of wick feeds have the disadvantage that they feed oil quite as rapidly when the journal is not running as when it is in motion. Although such waste can be avoided by lifting the wicks out of the standpipe or by shutting off the reservoir with a cock, this involves the risk that proper attention will not be given when starting or stopping the machine.

Sight-feed drip cups are often used in place of the "syphon" type of wick feed. Though they are subject to somewhat similar disadvantages, they have some advantages not possessed by the wick feed. The rate of feed of lubricant is more readily adjustable, the rate of supply of lubricant is visible, and they can furnish a greater rate of supply of oil than is possible with a wick feed.

Another form of capillary feeding device is one in which the oil reservoir is below the level of the bearing and the oil is raised by waste or wicking. Such an arrangement, commonly used on the smaller electric motors, may give a less rapid flow of oil than one with the reservoir above the bearing, but it furnishes an adequate supply for many purposes and has the advantage of requiring less attention, since the flow ceases when the shaft comes to rest. In addition, oil which escapes from the ends of the bearing can be caught and automatically returned to the reservoir for recirculation through the bearing. Even some bearings of quite a large size are equipped with this type of lubricator.

Waste Packed Bearing

Although waste-packed bearings supply oil continuously, the amount is usually insufficient to maintain complete film lubrication. Therefore, such lubricating means may be classified as one providing boundary lubrication. One of the commonest forms of waste-packed bearings is that employed on railway axle journals, a similar form being used on electric railway traction motors and other motors having similar service conditions to meet. Either wool or a mixture of wool and cotton waste is employed. The waste partially fills the recess cast in the housing below the bearing, and contacts either with the lower surface of the journal, as in axle bearings, or with a surface at one side of the bearing, as in railway motor bearings. The selection of the point of contact with the bearing, of course, depends upon the direction of the load on the bearing.

It is necessary in bearings of this type to have a good inclosure to ex-

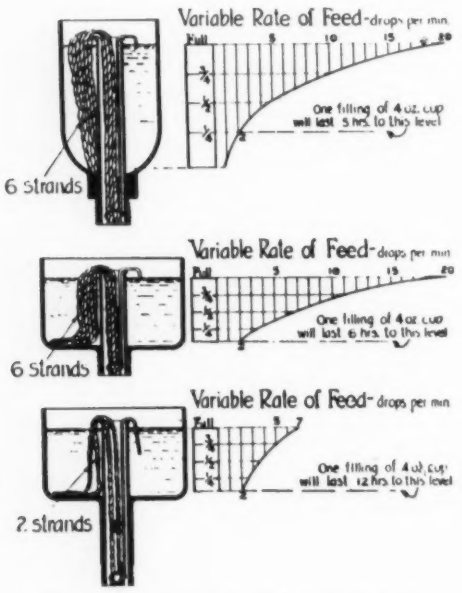

Variable Rate of Feed-drops per min.
Full
5
10
15
20
One filling of 4 oz. cup will last 5 hrs. to this level
6 Strands
Variable Rate of Feed-drops per min.
One filling of 4 oz. cup will last 6 hrs. to this level
6 Strands
Variable Rate of Feed-drops per min.
One filling of 4 oz. cup will last 12 hrs. to this level
2 strands

Fig. 2—Variation in the rate of feed is, for a given oil viscosity, greatly affected by the rate of feed and the proportions of the cup, the initial rate being about proportional to the number of strands of wick

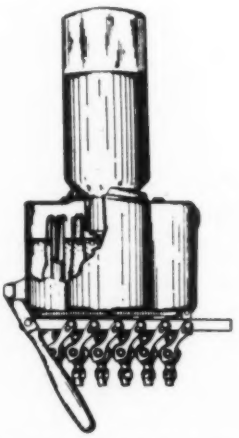


Fig. 3—Multiple wick-feed oiler with inverted bottle to maintain oil level and cocks to shut off lubricant when not required

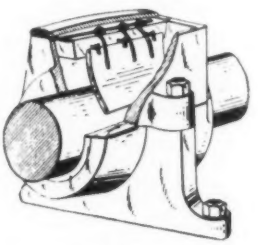


Fig. 5—Felt pad oiler with wicks arranged to feed from a tray above

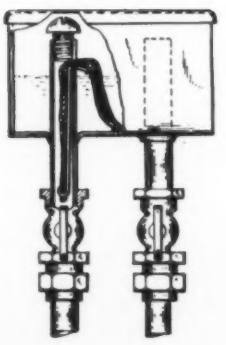


Fig. 4—With this type of wick-feed oiler the rate of oil flow can be adjusted by the screw

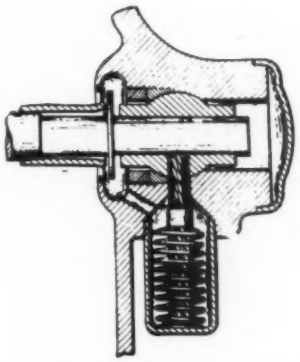


Fig. 6—Bottom-feed wick oiler with shaft collar and ducts to return the oil to the reservoir

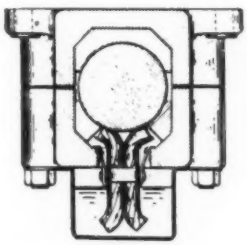


Fig. 7—Bearings in which the pressure is on the upper half can be well lubricated by this type of bottom-feed oiler

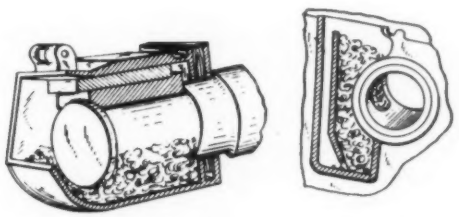


Fig. 8—Railroad car journal boxes are a well known example of waste-packed lubrication. To the right is shown the same method applied to electric railway motors

clude dust, grit and water. Oil seals or dust guards, or combination of these, are desirable if not essential features, especially if the oil supply is to be considered. With such arrangements, excellent lubrication is secured and the consumption of oil is comparatively low. The flow of oil is fairly uniform. Well designed railway axle bearings are reported to have consumed about one quart of oil in 6,000 miles of operation. As with other bearings depending upon capillary action in oil soaked fibrous materials, renewal or proper cleaning of the absorbent materials is required to prevent clogging and reduced feed of lubricant.

Any device capable of feeding either oil or grease to a bearing may be capable of providing partial film lubrication with a sufficient degree of regularity to give satisfaction under certain conditions. Some devices, such as the mechanical oiler or the bottle oiler, can be adjusted to give either partial or complete film. The primary consideration is usually user satisfaction, with due regard to first cost. Any system which approaches the ideal of requiring minimum attention on the part of the user, together with certainty that lubrication will not fail over long periods of time, has obvious advantages. Industrial users of machines, in particular, are often willing to pay the extra cost of an automatic system rather than be faced with the need for making up deficiencies or of providing extra labor to assure satisfactory lubrication after the machine is installed.

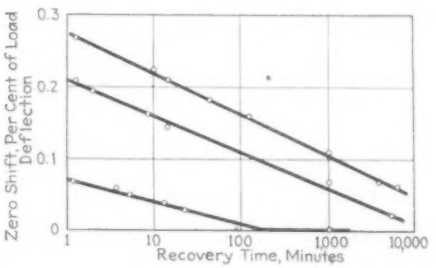
Errors in Instrument Springs

IN A PAPER presented at the Winter Convention of the A.I.E.E., Paul MacGahan and R. W. Carson, both of the Meter Engineering Department of the Westinghouse Electric & Manufacturing Company, described the major errors inherent in instrument springs, and explained how they can be overcome.

As the deflection of the spring in an instrument produces the controlling torque, it follows that the final accuracy of the instrument is, to a great extent, dependent upon the permanence and stability of the springs. The stability of an instrument spring is the ability of the spring to maintain its zero position and strength under variations in temperature, time, and load conditions found in service. Three unstable effects in spiral instrument springs are: (1) temperature change causing change in torque; (2) aging or a slow permanent change in zero position accompanied by a permanent change in torque; (3) elastic hysteresis or a slow increase in deflection under a steady load and a corresponding slow recovery of the zero position.

For phosphor bronze, the temperature coefficient of elastic modulus is approximately 0.04 per cent per deg. C. The aging effects result in a zero shift and a simultaneous change in strength of the spring during long periods of service. The zero shift, resulting from the uncoiling of the spring, may amount to 5 or 10 deg. of arc, while the spring torque may increase 2 to 5 per cent in the course of several months when service conditions are severe. Investigations disclose that these two effects are parallel and that the rate of change increases rapidly with an increase in operating temperature. The rate of uncoiling at 100 deg. C. is nearly 100,000 times as rapid as the rate at room temperature.

As an increasing outside diameter of the spring as formed results from greater internal stresses not relieved by the forming operation, it follows that aging in service is caused by residual stresses. Further investigation disclosed that aging of the spring in service could be eliminated by a mild heat-treatment at a temperature somewhat higher than temperatures usually found in service. Uncoiling, or relaxation of residual stresses, takes place very rapidly at temperatures of 100 to 150 deg. C.



Effect of load time on the elastic recovery of a phosphor bronze flat spring ribbon

Investigation of elastic hysteresis effects involved experiments requiring an exceptional degree of accuracy. The instrument used showed a displacement of 0.00001 in. when a piece of spring ribbon was placed on two parallel horizontal pins and loaded with a weight hung midway between.

Tests were conducted for determining the effect on elastic hysteresis of such variables as: composition, cold working, thermal treatment and residual stresses, temperature, duration and intensity of loading. Representative results of some of these tests are shown in the accompanying figure. A heat-treated ribbon of spring material was loaded for periods of one hour, five hours and twenty-five hours, and the elastic recovery measured. As shown in the figure, the recovery varies with the log of time until complete recovery took place, and the rate of creep decreased with increasing time under load.

EDITORIALS

KENNETH H. CONDIT
Editor

Fruits of Standardization

EVEN engineers are sometimes prone to regard standardization as more academic than practical in its value. Some standards have not been of great practical value, it is true, but there are plenty that have.

Particularly fruitful of profitable return is the standard that permits multiplying the size of the lot to be purchased. In one corporation, where standard parts can be used by several of the constituent companies, one company adopted a standard part used by another company. Result—cost of that part to the corporation, and to the standardizing company, reduced fifty per cent.

In the same organization a similar adoption by the largest constituent company of a part used by one of the smaller companies reduced the cost of that unit by five-sixths.

The easiest way to accomplish such results is within a corporation, but there is no reason why unrelated companies should not cooperate on standards, and secure the same economies for each company entering into the project.

■

Engineering Intolerance

One reason recently ascribed by the president of an automobile company for the sales success of his product was the fact there was absent from his technical staff what he termed "engineering intolerance." What he had reference to was the self-sufficient, know-it-all attitude that characterizes so many engineering departments. Too proud to accept or even listen to outside, lay advice—often forced to bluff their way through a difficult situation to sustain a feeling of superiority, a reaction that psychologists tell us is fundamentally but one form of an inferiority complex.

At times this attitude sets up a barrier between the sales and engineering departments, effectively preventing the latter from taking advantage of the field contacts of the former. Or it may appear in the form of destructive competition between companies. Recently a limited survey was made among the manufacturers of a special class of resale equipment. In each case the engineers interviewed modestly admitted they designed and built the best product, never conceding the competitor a single advantage. In several instances, as a result of this kind of slamming, the customer concluded that all were badly designed, and proceeded to build his own—the last word, he assured himself. Today this industry is young, but before it puts on long pants there will be fewer among its members. First to go will be the know-it-alls.

The really broad-gaged engineer looks at his job and his products with an open mind, ready to turn to advantage any constructive criticism that may come his way. He recognizes the strong points of competitive products, but instead of destructively attacking these advantages, he adds them to his own experience and proceeds to improve upon them. Engineering tolerance admits the fallibility of the human mind, concedes its own mistakes, grasps help from whatever source—gets there.

■

New Methods Make New Designs

New materials have led to many revolutions in design. New methods of manufacture or assembly offer equally attractive opportunities for design changes that will reduce production cost and thereby widen markets.

The airplane fuselage, for example, is now usually constructed of welded steel tubing. The exceptions are built up from duralumin shapes and sheet but are expensive because of the cost of drilling for and driving the innumerable small rivets.

If someone should develop a method of soldering or welding, or otherwise uniting such a duralumin structure, he would pave the way for radical changes in current designs.

The interest of the engineer in manufacturing developments is obvious. Why should he not come out of his shell and make his interest a real stimulus to the production department to renovate its methods and equipment?

COLOR

Where and How

Last month we sought to show how the scientific classification of colors puts the whole subject of finish application on a practical working basis. This installment of our serial on color gives the results of many interviews with color authorities on the broad subject of introducing colors to machinery and metal products. The next will continue the present discussion and begin a symposium on how market studies are used to determine these colors

WHAT COLOR to use on any given product is bound to be a question of vital concern to the designer. It has been shown in preceding articles that by proper choice of color combinations the product can be made to appear longer, shorter, or more graceful, or that it can actually stimulate the senses. But no designer is privileged to sit down and choose the color combinations for his product with only his own individual conceptions of the product in mind. There is the important problem of the ultimate environment of the product, that is, the final effect as seen when the machine is placed in conjunction with other machines or set in among other products; and there is the factor of the buyer's changing habits and styles which must also be considered.

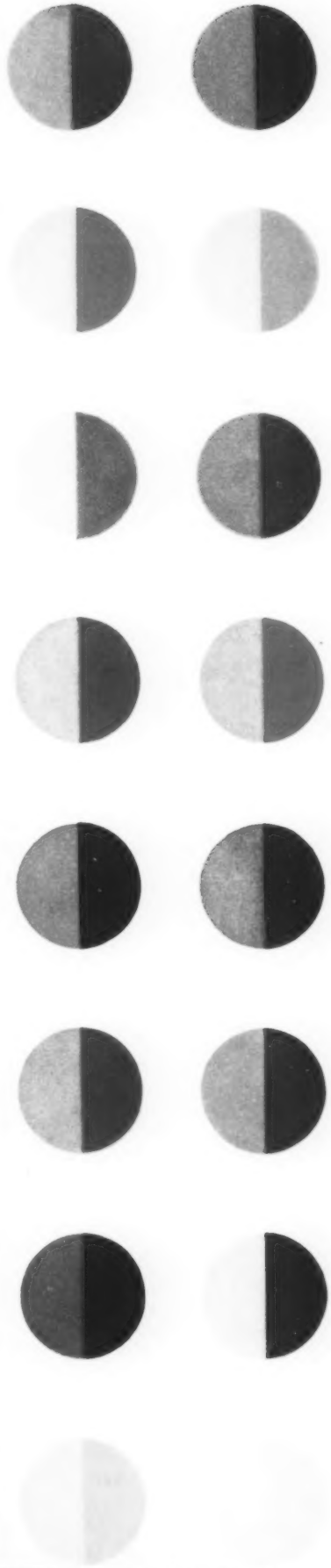
In the preceding article one method of color analysis and classification was given that would enable the engineer to arrive at a working basis for color harmony in his products, or as it were, to talk the same color language as the artist. In the application of color to a product in the form of a pigment paint, lacquer or enamel, or as a dye, it must be understood, however, at the very outset, that color is not a material thing as a property of a paint, but is rather a sensation arising from the activity of the eye in response to light.

The fact that two hues may produce similar color sensations when compared under white light does not mean that they are identical in every respect. These two hues may give sensations of entirely separate colors when inspected under a light that is not white, and colors may change their hue and chroma at different rates under exposure. This arises from the difference in the wave lengths of the light that creates the sensation of color. Any difference in the absorptive power of the pigment in the finish also makes a complicated condition for the engineer in the matching of colors. All this means that where the finish of his product is of great importance, as in household machines and office appliances, he must standardize and prevent as far as possible indiscriminate selection of untried finishes.

Color Is An Impression

The individuality of the pigment on the surface of an object also determines what colors of the spectrum can light it. If an object is blue, only the blue light rays can be reflected, the others having no apparent effect. We accordingly receive the impression of blue. The same applies to all the colors of the spectrum.

But when a colored light is directed on an object it tends to subdue that specific color if that same color is found in the finish of the article. For instance, if a light predominating in blue shines on a green article the blue of the green is lessened with a resulting impression of yellow (the



WHEN white is added, colors become "tints." One company standardized on sixteen colors, with their tints, as suitable for most uses

MECHANICAL packaging has developed with a new technique. Articles, such as steel-tape reels, boxes, and fishing reels, formerly made of metal, are being designed in varicolored molded plastics.

other part of the green mixture, yellow and blue). So too, if a light predominating in yellow shines on a green, an impression of blue will result, making the object appear more blue than it really is. If the color of the object contains none of the color of the light, the two will blend to form a new color as in the mixing of pigments. Thus, a blue light shining upon a yellow object would make the object appear green.

A further illustration of this (though an apparent contradiction) would be to paint a large surface with a gray prepared by mixing black and white. Upon this gray a large gray number is painted, using for the second gray, one prepared by mixing two complementary colors, as blue and orange. At a distance this mixture appears as a solid gray to the naked eye, but on looking through an orange glass one would see a blue number; through a blue glass, an orange number.

Standard Lighting

Any change in the color of the light source provides at once a change in the intensity of the wave lengths reflected from the surface of the finished product, and since any variety or intensity of light is likely to be found where the various products of different manufacturers are used together, it is highly important that the standard mix of the finishing material be made under a light that is standard. This is done by all reliable paint manufacturers. Some electrical manufacturers have produced lights especially designed for color matching, but where these are not available to the engineer an average daylight from a northern exposure is still considered a good medium for inspection.

Assuming, therefore, that the engineer can be satisfied that any good quality of finishing material will meet the requirements of color matching if originally matched under a standard light, the large task that confronts him is the choice of the right color combination for his product. For the answer to this problem a thorough study of the buyer's habits is the first requirement.

There is the case in point of the maker of electric refrigerators who figured that since kitchens were being painted in various light colors, and small objects such as clocks and utensils were being sold successfully for kitchen use in greens, yellows and pinks, he should produce his refrigerators in these colors. But the attempt was unsuccessful. His study of the "psychology" of the buyer did not go far enough to show that in a relatively expensive product the buyer required a white or neutral color that would match the frequent changes in household color styles, and thus not require refinishing.

In fact, practically every manufacturer of electrical refrigerators has at one time or another tried to introduce color on his product, but without great success. Besides the reason given above, it is considered that the demand for pure white in the interior of the refrigerator for sanitary reasons has a bearing on the exterior coloring. In the case of market scales for weighing foodstuffs, especially meats, the Toledo Scale Company found that its sales of scales were reduced when the weighing plate was cream or buff or any tint slightly off pure white. This led the company to make extensive researches into molding compounds that would give a pure white color, and to the establishment of a specialized molding plant.

Industrial Machinery Colors

In the case of industrial machinery the selection of the color may be taken entirely out of the hands of the designer by the fact that definite color schemes are usually already selected for the plants where the machines are to be installed. Almost all machine tools are painted originally a gray, as this color, or neutral lack of color, was selected as a standard because of the inability to decide upon any hue that would meet the tastes of all individual plant managers. While the gray value may be considered as non-attractive in itself, and conducive to a gloomy appearance in the plant where the machine is installed, the choice as a standard for original painting may be considered as fortunate since it provides a standard base-coat of finish suitable for adding any hue after the machine is installed.

There is no possibility that the great variety of buyers of machinery will ever agree on one or two hues as standards for all plant machinery because of the differences in human reactions to the different color sensations and the difference in effects desired for different classes of workmen who use the machines. In choosing a gray for his machines the designer should be guided by the light-reflection factor to suit the type of plant where the machine is to be used. This reflection factor can be seen on the chart in the preceding article (*PE*—Feb. p. 65). When a suitable gray has been selected very pleasing effects can be worked out by the addition of small amounts of other hues, that is, by adding a small amount of green or red to relieve the coldness of gray.

Outside Designer's Control

Another case in point where the color selection may frequently be outside of the control of the designer is in road and construction machinery where municipal or state authorities may dictate standard colors. This class of equipment was formerly almost always painted black or in dark colors. The psychology of the market now calls for bright colors and their exhilarating effect. There is also a utility value in these bright hues as they can be seen readily from a distance and thus be guarded from collision with passing traffic. One maker of road rollers employs bright red and bright orange as standard colors, using a heavy durable paint that will withstand cleaning without looking shabby, this class of machine being subjected to exposure to mud, oil, and grit. In a study made by Dr. Luckiesh, deep orange was shown to be the color giving the most exciting stimulus to the workman, and since this color is one that will be vividly apparent if the machine is in the way of passing traffic, its choice for a construction machine of this class seems apt. However, some highway departments of various states have standardized on grays and other colors for all their equipment, and machines going to them must conform to the particular standard. This affects likewise such machines as graders and scrapers that are normally painted in reds and greens.

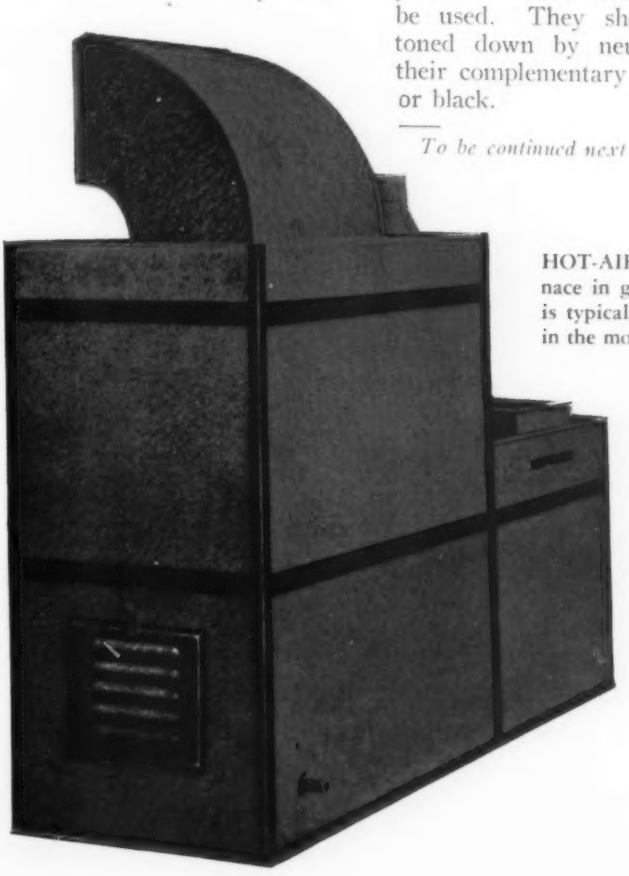
Another example of the use of bright colors for visibility is at the plant of the National Cash Register Company where, as a safety feature, all moving trucks are painted orange. On the other hand, because of the restless and forceful impression orange conveys, it should not be used for production machinery in a plant where regular and even work is required over long periods of time. However, orange has been used successfully for laundry washing machinery that is installed often in basements with dull surroundings and concrete floors, and a few cases exist where this color has been employed for high-production machines. Red, likewise, is too nerve stimulating for use on workshop machinery, but is employed on fire apparatus or machine guards.

Designers of mill machinery, whether rolling mill equipment or textile production machinery, are in about the same position as the designer of machine tools in regard to the specification of color for their products. The standard color adopted by the particular mill manager for his plant determines the final finishing color of the machine, and a light shade of gray as the standard will make it easy to apply any color for the final coat. One large producer of paint pigments, the New Jersey Zinc Company, has been trying very aptly to get manufacturers to find out from their salesmen where the special or mill machinery is to be placed and something of the conditions under which the machines are to be operated. This company recognizes that a machine manufacturer should be in a position to offer an initial finish color that will result in a harmonious whole and still be of such a nature as to stimulate production.

Color Depends on Light

On the determination of the proper colors for the machines that are to be placed in a room, Lee Moffitt of the Duco Color Advisory Service points out that the eventual colors are dependent upon the size, exposure and general lighting of the room. The lighting is further dependent upon the proper reflective qualities of the walls and the nature of the window panes whether transparent, or merely translucent. He further states that the quality of light is of first consideration, that is, whether it be of north, east, south or west in exposure. In interior decorating this has been considered of utmost importance. It follows that the same applies to industrial rooms although they be of a more simple nature. If a well lighted room has a southern exposure where the sun streams in, it behooves us to counteract this impression of heat and dazzling brilliance. We accordingly introduce the use of "cool" colors, i.e. cool greens or blues. This will help soften the glare and will create a welcome effect in the heat of summer when the sun becomes oppressive. Pure colors should never be used. They should always be toned down by neutralization with their complementary color and white or black.

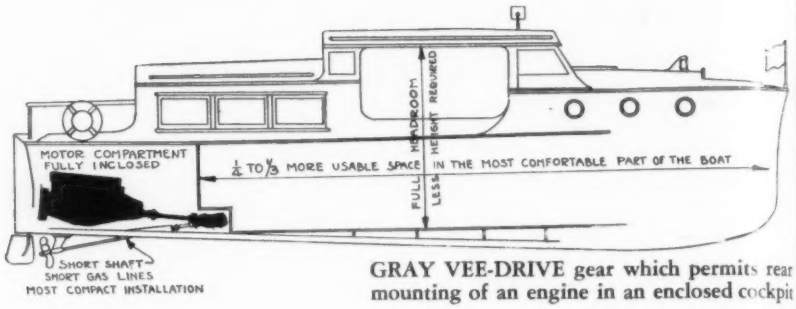
To be continued next month.



HOT-AIR humidifier furnace in green and black that is typical of the installations in the modern home cellar

THREE NATIONAL SHOWS

Boats — Heating and Ventilating — Canning Machinery



GRAY VEE-DRIVE gear which permits rear mounting of an engine in an enclosed cockpit

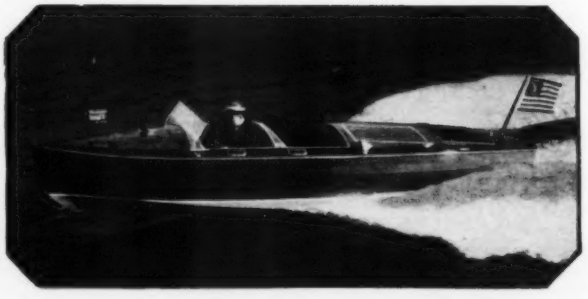
Motorboats Adopt Motor Car Engineering

MOTORBOATING and sailing, showing steady increases in popularity, are becoming important fields for the product engineer. More and more boats, engines and accessories are being produced, now on a mass-production, lower-price basis, to meet the demands of a market that totalled $6,000,000 last year in New York City alone . . . That figure does not include outboard and large yacht types, and is fairly representative of a country that last year held over 4,000 motorboat regattas, a new high record.

Adaptation of motor car designs, particularly in engines, wider diversity of materials, new types of craft of every price class, first use of diesels on stock cruisers, beginnings of a trend toward rear enclosed engine mountings, new silencing, muffling, and fume-avoiding devices, and an increasing range of accessories characterized this year's Motorboat Show at Grand Central Palace, New York. Larger boats, being adapted for "family use," now have wider hulls and other changes to increase stability, more comfortable sleeping accomodations, completely outfitted galleys, electric iceboxes, running hot and cold water, inclosed cabins and protected cockpits, built-in radios, fancy upholstery, cigar lighters and similar "luxury" fittings, and all manner of gewgaws to charm the ladies and annoy the saltier seamen. Ross cam-and-lever and other motor car steering devices provide greater ease in handling.

Largest boats shown were the 50-ft. Wheeler, Elco, and A.C.F. cruisers, which top off their lists of innovations with such things as built-in hot and cold fresh and salt-water showers, tiled bathrooms, an oven and broiler in the galley, hot-water heating systems and tiled fireplaces. . . . These last two are the engineer's answer to the need for a "year-round" boat . . . Wheeler has five stock cruisers, 42 to 70 ft. in length, powered with Winton diesels . . . Dodge engineers have a 19-ft., 8-passenger "all-purpose" boat with broader beam and heavier keel to increase stability. . . . Mullins now makes four 16-ft. all-steel boats with Lycoming engines, Auto-Lite starters and lighting systems . . . Decreased draft and shallow-water propeller protection are provided by housing the propeller of the "Camp Mate" model in a stern tunnel . . . Many boats show better streamlining, particularly one small craft with the true "tear-drop" shape . . . Among small craft, clever engineering is shown in the "Padsea" boat for children, a hand-power side-wheeler, about 2½x6 ft., weighing but 50 lb. . . . Another innovation is the "General 14" boat, controlled by a regulation airplane "joystick."

Increasing numbers of diesels were a Show feature . . . The Ailsa Craig, English importation using standard cast-iron blocks and cylinders, gets 12-16 hp. with a 2-cycle diesel weighing 600 lb., 20-30 hp. with one weighing 1,120 lb., 60-90 hp. with a 6-cyl. unit weighing 2,240 lb. . . . The Buda M.A.N. gets 125 hp. at 1,500 r.p.m. and 75 B.M.E.P. with a 2,900-lb. engine . . . Its materials are representative of today's trend in engines . . . A Ni-Chrome cylinder and crankcase one-piece casting has Ni-Chrome cylinder liners inserted . . . Ni-Chrome cylinder heads have aluminum covers, pistons are aluminum alloy, crankshafts and connecting rods drop-forged, the latter rifle-drilled, valves Silchrome steel, most bearings bronze bushed or bronze-backed babbitt, except fuel-injection pump shaft, where ball bearings are used . . .



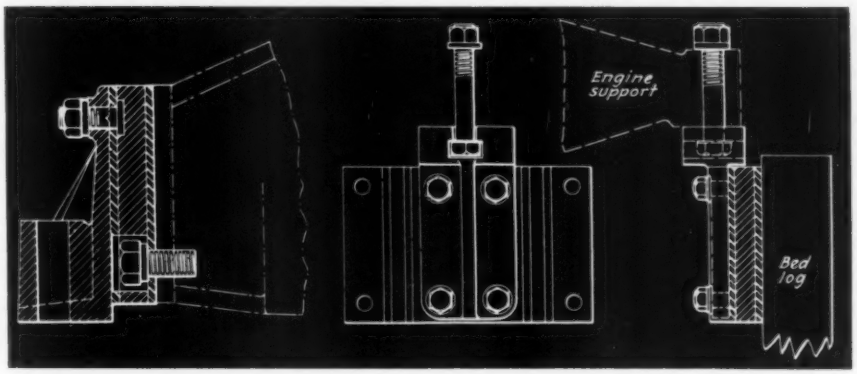
23-ft. Hackercraft, equipped with Tobin bronze shafting and Everdur fittings

water pump shaft is stainless steel.

Among standard gasoline engines, the new Alfco V-type 12-cyl. attains 244 hp. at 2,800 r.p.m. with weight of 2,559 lb. . . . Buda Hivelo uses double annular and end ball thrust bearings, has an enclosed flywheel, aluminum oilpan, 6 cyl. cast enbloc to attain 81 hp. at 2,800 r.p.m. . . . Kermath has a water-cooled, separately lubricated reduction gear and gets 50-85 hp. at 2,000-3,000 r.p.m. with weight of 800 lb. . . . Universal's Blue Jacket Six has a silent herringbone-gear reduction drive and counterweighted crankshaft to reduce vibration, and attains 75 hp. at 4,000 r.p.m., yet weighs less than 500 lb. . . . Counterweighted crankshafts are almost standard now.

The Fay & Bower Rocket has an aluminum alloy block and other parts, made from a sea-resisting alloy using nickel instead of copper as the alloying agent . . . Ford Model A engines, commonly used in boats, are adapted easily with a "Joe's" bell housing and reverse gear that bolts directly to engine flywheel housing.

Outboard engineers continue their efforts to cut weight and improve performance . . . Prices are, however, off about 20 per cent . . . Johnson showed the lightest, a 27-lb. single-cylinder unit . . . Other "Sea Horses" have 10 per cent power increases through better machining and refinements . . . Caille 4-hp. "Featherweights" weigh only 34 lb., have an over-all length of 30 in., and retail for less than $80 . . . Lubrication is, as usual by oil mixed with gasoline . . . Propeller and drive shafts are stainless steel, cast Lynite propeller, drop-forged and ground chrome-nickel crank-shaft, aluminum gasoline tank, chrome-nickel steel gears, light-weight alloy pistons, cadmium-plated screws and nuts, grey-iron cadmium-plated cylinder, cadmium-plated bronze drive-shaft housing, forged bronze connecting rod, two-piece Lynite crankcase, with phosphor-bronze bearings pressed in . . . Evinrude, as do some others, has honed cylinder blocks, materials somewhat similar to the Caille . . . Larger Evinrudes have electric starting and shock-absorbing steering handle springs, all have a gearless rotary fuel valve built as part of the crankshaft . . . Two-cycle outboards are lubricated by oil in gasoline, are claimed to exhaust fumes and to vibrate considerably . . . Four-cycle outboards, just announced by Van Blerck and Cross, have separate pressure oiling systems . . . Van Blerck has a chain propeller drive . . . Cross uses cast aluminum cylinder heads and blocks, with nickel iron cylinder sleeves and valve seats inserted . . . Crankcase and fuel tank are pressed aluminum . . . The result is low weight—95 lb. for 20 hp. . . . Cross uses ball bearings throughout; Neptune Twins use ball and roller . . . Directly opposed cylinders of the Neptune fire together to cut vibration . . . The old hydroplane principle is used in a new "Blow Motor" which has either a 1- or 2-cycle engine driving a 4-blade air propeller.



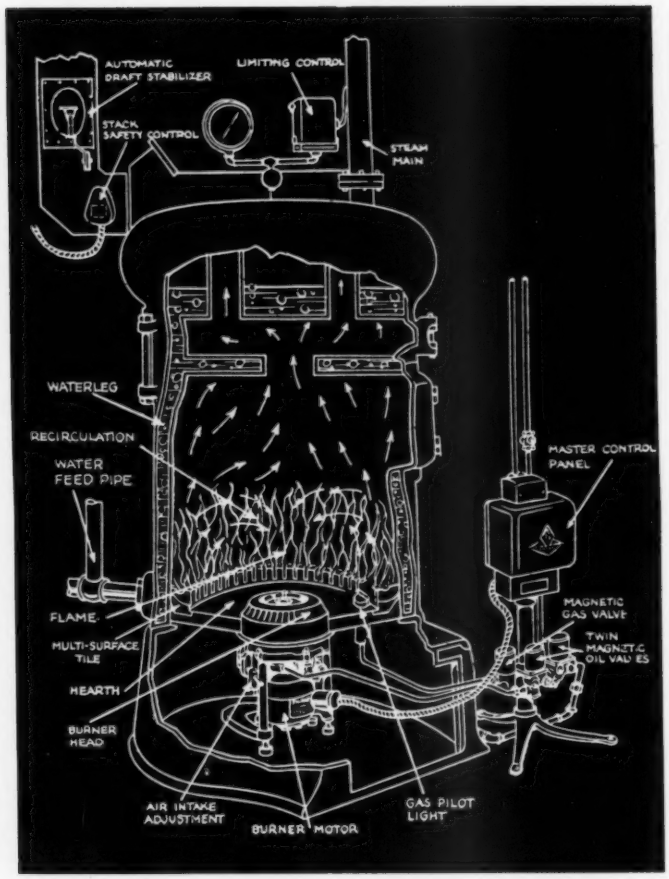
"FLOATING POWER" marine engine mounting, which places rubber, bonded between steel plates, in tension instead of compression. One mounting supported 2,500 lb. at the Show

Accessories included self-inflating life-saving garments (compressed air) . . . Dunlop has non-sinkable cushion rubber boat fenders, composed of a sponge-rubber filling in a smooth resilient rubber tube or cover, colored either white or mahogany . . . National Lock Washer engineers have adapted the Pitot tube principle for a pressure-operated marine speedometer . . . Slow-speed or trolling devices for outboards include a hinged plate back of the propeller that is sprung to resist motion at low speeds, but rises under high speeds to let the propeller drive clear . . . Caille joins the ranks of adjustable-pitch propellers with a multi-flex control which includes a fork-type sleeve-operated clutch that alters propeller blade pitch and is controlled by raising or lowering the steering handle . . . Flexible metal fuel line hose, now coming into prominence, is an adaptation of the accordion-pleat idea first used on Government airplanes in 1919 . . . Steel forging flanges, tapered shaft connections if desired, and enclosing grease cases have been devised for Francke flexible couplings . . . Joe Hartmann has devised an asbestos dry-disk one-way clutch for light service, assembled to shafts like a flange coupling . . . Pyrotechnic signal flares, now adapted for small boat kits, contain a pistol that shoots a cartridge 250 ft. into the air, where a 30-in. parachute opens to suspend a 30,000 or 50,000 candlepower light for 30 sec. . . . Strombos has a drift alarm that is a simple combination of small anchor, line, switch, and electric buzzer.

Marine engine-designers have diversified their designs in some instances to produce products entirely unrelated to a boat . . . An example is the Johnson portable centrifugal pump, driven by an adapted outboard motor . . . Another is the Muncie power lawn mower adapted-boat-motor driven . . . Several farm-type clothes washing machines are driven by adapted outboards.

Heating and Ventilating Now Virtually Automatic

OIL BURNERS are special machines—with motor pump, fan, regulator valve, filter, radio "filterette," thermostat—but service conditions demand they operate continuously and efficiently without expert attention and with only once-a-year lubrication. Intense competition has resulted in design refinements in all details . . . quietness gained by



Modern household furnaces are automatic machines, whether gas, oil, or coal fired. This "Silent Automatic" is typical. See illustration on page 115 of trim lines of modern gas-burning air furnace

compact piping, better nozzles, and flexible suspension. Compactness of appearance and bright colors—red, orange, green—are featured. Self-cleaning filters and efficient nozzles permit use of low-grade oils. Trend is for hotter flame by atomizing. Petro-Nokol, for round boilers, has a rotary atomizing plate driven by $\frac{1}{20}$-hp. motor under the firebox. Mechanism is inside the boiler. "Model T" has an atomizing cup on the motor shaft above the fan . . . flow of oil to cup is by gravity . . . atomizing is by high peripheral speed. Nothing is outside boiler but control panel and oil tank. Timken, A B C, and Toridheet oil burners are also rotary type with low-velocity, wall-sweeping flame, quiet in operation and enclosed under the boiler. Many engineers have developed their own oil pump . . . it is highly efficient and will be offered also for hydraulic applications . . . Gilbert & Barker "flexible flame" burner has separate control for air and oil with two streams of air into the atomized oil for complete combustion and hot flame . . . Century has gas attachment for changing the same machine from oil to gas burning . . . oil pump creates pressure against the gas valve, this pressure regulating amount of gas being used.

York engineers advocate special boilers for real high efficiency in oil burning . . . York boiler has round molded chamber of refractory cement of proper size and shape for near theoretic combustion . . . Others claim the more efficient rectangular boiler will permit satisfactory flame application if length is not more than twice width . . . American Radiator "No. 12" boiler designed especially for oil burners, either rotary or gun type, is rectangular cast-iron — hot gases travel four times back and forth through gallery flues.

Old-line furnaces have been improved with better insulation, roller-bearing grates, humidifier attachments, and motor driven circulating fans . . . Where coal-burning is retained furnaces have automatic stokers or magazine feeds. The Motorstokor uses buckwheat coal, is fully automatic, feeding coal by screw conveyor and removing ashes by an inclosed buck-and-chain elevator . . . Moncrief household boiler has air preheater, four-layer asbestos air-cell insulation jacketed with steel in cardinal red color . . . Columbus Humidifier Company has an automatic low-priced humidifier for attachment to any type furnace . . . Richardson & Boynton has a clothes-drying compartment of sheet steel for attachment to boilers . . . this company's new "Blue Streak" boiler is a round boiler covered with rectangular asbestos-lined steel casing finished in bright blue lacquer for the modern attractive cellar . . . Surface Combustion Corporation's gas-fired furnace is rectangular with rust-resisting steel combustion chamber between two side radiators. The humidifying unit at the top of the combustion chamber has an automatic control tank. Control of gas and secondary air are automatic from thermostat.

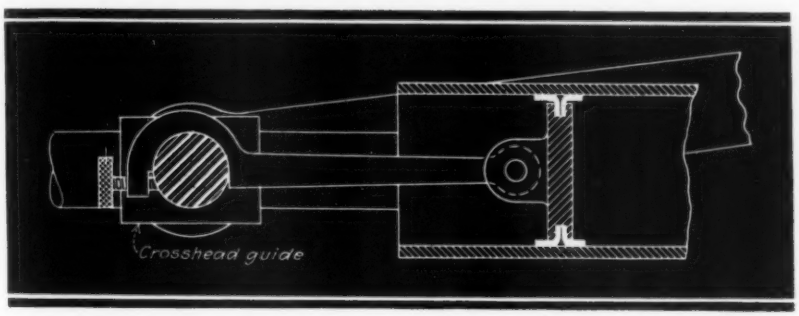
Air-Conditioned Houses

Air conditioning is coming for all dwelling houses. This year's Show offers several units as commercial successes with full automatic control . . . Moisture is added to air automatically to produce normal healthful atmosphere in rooms . . . Air conditioners also cool air in summer . . . Moncrief gas furnace has Emerson blower with eight speeds by regulation of control unit or three selected speeds by means of switch . . . blower is controlled by thermostat . . . drip humidifier has automatic control from water pipe . . . Columbus Heatmaster has twin multiblade motor-driven fan, air-cleaning filters, automatic control of humidity and thermostat — Silica Gel Corporation air-conditioning unit has beds of silica gel for dehumidifying the air necessary for summer operation . . . The Carrier "Weathermaker" is a compact complete heating plant. Air is drawn from the rooms, passes through filters, circulated by blower around a gas-fired "heat interchanger" and then through the vaporizer . . . water in vaporizer is controlled automatically by float valve and humidity is regulated through water temperature by control on gas valve . . . The Holland Furnace Company's air-conditioning unit for attachment to warm-air furnaces has a high-speed twin fan driven by a $\frac{1}{4}$-hp. motor to draw the air through a copper-mesh filter and then force it through a series of water sprays . . . air is then drawn through cooler and filter . . . Parks-Cramer offers a small compact humidifying unit to connect easily with water supply and plug into electric connection . . . consumes only same current as ordinary electric lamp . . . Campbell

Metal Window Corporation offers a "Maxim-Campbell Silencer" for attachment to city windows to admit clean, filtered air without street noises.

Unit heaters for industrial and commercial buildings offer economy of space with uniform heat. They are steam, electric, or gas . . . The Humphrey gas heater is compact and self contained . . . The gas pilots have safety thermostatic control automatically cutting out motor and gas if pilots are extinguished . . . heating flame is distributed between vertical radiators . . . fan at rear forces air between radiator directly to room . . . Surface Combustion Corp. unit is also fully automatic . . . American electric heater elements consist of helicoid sheath wire strips cast integrally within aluminum alloy fins . . . motor-driven fan in rear drives all through. McCord steam unit has seamless copper tubes with extra-wide spiral fins their full length to circulate the heat in front of the fan blast . . . The Sturtevant unit has crimped helically-wound copper fins to cut air into small streams.

Canning Machinery Plays Up Corrosion-Resistant Materials



A QUICK-DETACHABLE connecting rod is a feature of this six-plunger mayonnaise filler pump. The crossbar reciprocates on bar slides

THE EXHIBIT of canning machinery and supplies in conjunction with the National Canners Convention in Chicago Jan. 25 to 29, shows convincingly that this class of equipment is one of the largest outlets for the new corrosion-resistant materials . . . Contamination of food by its own corrosive action is the chief problem, rather than attack on the machine . . . A flotation-principle pea grader, for example, is made entirely of pure nickel, fusion welded at corners, with angular strips spot welded to sides for rigidity . . . In fact, many materials have been selected for ease in welding as much as for corrosion-resistance . . . Among such units are a vacuum pan of stainless steel and a cooking kettle of Inco chrome-nickel. The two semi-spherical bases of the latter are made in five orange peel sections welded together. A racking gland at the outlet pipe allows outer and inner shells to adjust themselves to temperature changes.

A tomato filler has all parts that come in contact with the liquor made of Allegheny metal . . . Most feed hoppers are optionally stainless steel, nickel or Monel metal. Aluminum is used where lightness is important, as in the movable head of a capping machine . . . Plated or dipped finishes are used also. Silver-plated and tinned bronzes appear in several machines . . . In a sauerkraut filling machine, chromium-plated bronze plungers are used in conjunction with Monel metal cylinders, the only combination that would not result in co-deposition of metals in the presence of hot lactic acid and brine.

There is a definite trend toward completely automatic packing, evacuating, capping, and labeling of cans and bottles or jars, now made to withstand rough usage . . . In fact, more equipment was shown for filling glassware than tin cans . . . Most machines follow the general pattern in which a multiple turret head and table revolve about a central column upon which are mounted fixed track cams to control filling or closing plungers . . . Every conceivable type of cam is used with link and crank mechanisms. In all bottle and jar machines, a slat conveyor is standard, consisting of malleable iron plates of 2-in. pitch with width to suit.

Planned lubrication is receiving more attention this year than ever before. Every journal within reach has an Alemite, Dot or Zerk fitting ready for the grease gun . . . In one evacuating and capping machine even a roller cam follower has its pressure grease fitting . . . Where bearings themselves are inaccessible, pressure nibs are often brought out to a central point . . . Few anti-friction bearings are used, and these only on main drive shafts and worm gear units . . . Link-motion bearings are mostly cast-iron journals without bushings. In several instances open-gear drives have been replaced by gear boxes running in oil or self-enclosed worm and gear drives . . . Guarding of exposed parts has been refined.

For drive mediums roller chains predominate, except for motor drive, usually by silent chain, V-belt, or occasionally flat leather belt . . . Few machines are designed for belt drive from lineshaft . . . In one machine roller chain over a sprocket forms a cable connection between a cam follower arm and a tension spring which holds the roller in place . . . Two machines incorporate flexible shaft drives to cap feed hoppers.

Because of the necessity of washingdown, motors are fully enclosed types . . . More attention is being paid to push-button control and safety devices such as overload switches.

Glass Linings

Pfaudler's latest glass-lined percolator for the flavor extracts industry has two Pyrex glass observation windows with electric lights behind them for interior illumination. The top cover, held down by quick-action clamps, is sealed with a rubber ring. The liquor is recirculated through a simple motor-driven pump which can be quickly disassembled for cleaning by means of a coverplate held in place by a capstan screw and C-clamp . . . Glass-lined open mixers made by this company have a three-bladed propeller of Monel metal or phosphor bronze projecting through one side. The bearing body is sealed with a cork gasket and the impeller shaft is packed with cork, asbestos, lead or hemp, according to the liquid being mixed. It discharges through a silver-plated globe valve in a tinned bronze

bushing outlet . . . A larger size mixer is equipped with a horizontal squirrel-type agitator made of tinned bronze and driven by a motor through a bevel gear drive.

The tendency to combine operations is illustrated in the White bottle capper wherein the bottle is evacuated and the rim and cap sterilized at the time it is pressed on. Bottles are carried under a long hood into which live steam is injected, producing a sterilizing effect and assuring a vacuum upon condensation when the bottle is capped and cooled. Bottles are conveyed on a flat malleable-iron slat belt and pick up caps from a magazine. Immediately the caps are pressed on through a smaller belt conveyor of much finer pitch placed above, the forward end of which is backed by an oscillating platen actuated through a rocker arm and link motion. Both belts travel at the same speed. The entire head carrying the steam hood is aluminum and is adjusted for height by means of screw jacks and hand crank. Caps are fed from a rotary selector hopper with its driving motor bolted to the under side. Spacing of the bottles on the conveyor belt is obtained through an adjustable end cam and rocker arm with a trip latch in contact with a row of bottles being fed to the machine.

Cam-and-Air Closing

In Crown Cork & Seal Company's Jumbo vacuum crowner air cylinders slide the vacuum chamber sleeves over bottles in a six-station revolving turret machine. Trip bars on the columns that support the head throw the 2-way air valve as it passes these stations. Closure pressure supplied by upward motion of the bottle support plate is actuated through a stationary track cam below.

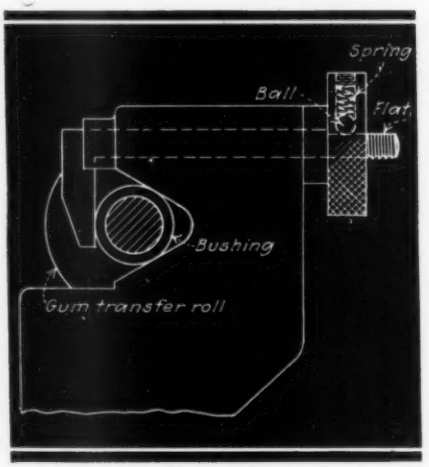
Aside from those machines in which the entire head rotates, several are shown with indexing type tables with single vacuum and capping heads . . . In one capper, indexing is done by a vertical Geneva motion through a bevel gear drive. In a hand loaded machine, a latch with stop pins is actuated by a crank and pivoted arm to index the table one station at each cycle of the pressure plunger.

Filling machines show several new departures . . . By substituting truncated sectors for the usual round cylinder ten filling pocket plungers are obtained in the Sprague-Sells filler in the space formerly occupied by six round plungers . . . Capacity is raised to 300 cans per minute . . . In this machine the flat-bottom hopper is stationary and has a sector cut out to expose the filler bowl with its ten pockets beneath. Stationary track cams and roller followers control filling and discharging of these pockets. By means of a trigger finger, if no can is presented to a filling station, the cam follower of that particular plunger is automatically side-tracked, and the material returned to the hopper.

A similar arrangement on the Elgin filling machine uses an entirely different principle of construction. Here cylinders and cup-packed pistons are arranged radially in a horizontal plane and connecting rods are hooked to a central radial groove cam. This machine is also of the merry-go-round type.

Running in Oil

The Horix-Haller automatic bottle filler and capper represents advanced engineering, with complete mechanical protection and the roller chain drive and main radial cam for cap closure completely submerged in oil. Leakage is prevented at the main drive shaft by duplex "Perfect" leather seals. Drive from the motor is by a guarded silent chain. Off the other end of the drive shaft, which is mounted on roller bearings, is taken a flexible shaft drive to the cap hopper. This machine is of the rotary turret type with a fixed track cam to raise bottles to the filling and evacuating positions. Spring-backed swing gates at both entrance and exit to the turret table throw the main clutch if a bottle is jammed. Link connections to the same throwout give protection should a bottle be stuck on the filling nipple, or should the nipple fail to pass into an undersize neck. In this latter event, the bottle base plate, which ordinarily is elevated on a mandrel through a spring-backed ball resting in a groove, is dropped by the pressure developed, and the interference trips the clutch.



"WORLD" BOTTLE LABELER. As soon as the knurled nut is backed off a few turns, the ball catches the flat and flips the latch bar, releasing the gum transfer roller

In the "Impacta" filling machine for bottling viscous materials such as mayonnaise, the helical gear pump body, of silver-plated bronze, forms part of the structure. Similarly, the column that supports the pump is the back of the Reeves variable-speed drive, mounted in a vertical position. Through it the speed of the gear pump is varied to suit the capacity of the jar. Bronze or stainless steel gears are optional. Outside packing glands are used at the nickel-steel shafts. The distributor head at the revolving table is silver-plated bronze. Main drive from the motor is by worm and wheel, supported on angular-contact ball bearings, with friction drive to the table and roller chain to the variable-speed drive.

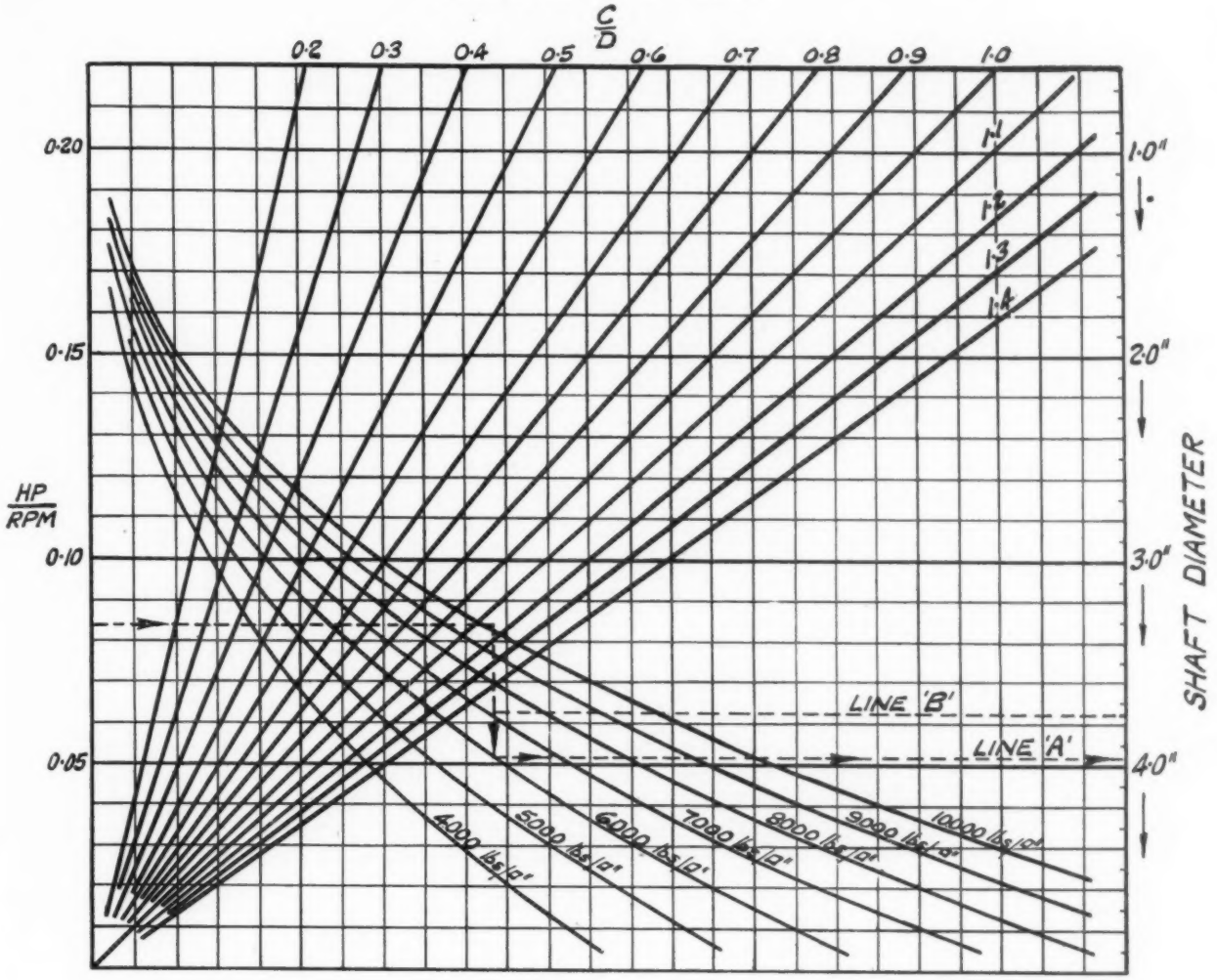
Another example of machine refinement is the "World" hand bottle labeler. In place of the exposed and noisy gear train is an enclosed worm and wheel drive connected by V-belt to the motor and through a flat leather belt to the cam shaft. In a fully automatic machine made by the same company, labels are placed accurately on two sides of glass jars while they are conveyed through the machine on a malleable-iron slat conveyor. First, the bottle itself is gummed in the center by means of a sponge rubber pad loaded by a transfer rubber roller, then the label is gummed at the edges, pulled from the bottom of the pack, pressed on the bottle, and later squeezed in position between sponge-rubber-faced grips. Since the link motions of the gum wipers are identical on each side, a single cam suffices for each pair of motions which are coordinated through a scotch yoke guided in a sliding vertical bearing.

Complete Redesign Halves Size

Through complete redesign, Sprague-Sells Corporation has halved floor space and increased capacity of its corn-cutter, now a combination machine for both whole grain and crushed corn. Corn is not forced through a series of fixed knives; it is fed through two sets of rotary knives arranged in the form of an iris diaphragm. Springs allows the knives to adjust themselves to varying cob diameters. Feed roll shafts are mounted on spring arms and are driven through universal joints so that they position for diameter.

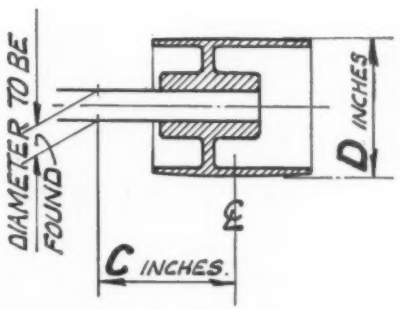
Chart for Overhung Shafts

REFERENCE BOOK SHEET



THE CURVES GIVE THE MINIMUM PERMISSIBLE DIAMETER OF A SHAFT AT ANY POINT BETWEEN ℄ OF BELT AND ℄ OF BEARING WHEN THE PULLEY IS OVERHUNG.

EXAMPLE: ELECTRIC MOTOR 75 H.P., 900 RPM, FITTED WITH PULLEY 10" DIA × 16" FACE STRESS NOT TO EXCEED 6000 lbs/□" MAXIMUM BENDING MOMENT ASSUMED TO OCCUR AT NECK OF BEARING – 3½" FROM EDGE OF PULLEY.---- $\frac{HP}{RPM} = 0.084$ AND $\frac{C}{D} = \frac{8+3.5}{10} = 1.15$



DOTTED LINE 'A' SHOWS THE DIAMETER AT THE NECK OF BEARING MUST NOT BE LESS THAN 3·97! HAD THE DIAMETER BEEN FIXED AT 3·75" THE STRESS (SEE DOTTED LINE 'B') WOULD BE 7100 lbs/□"

THE CURVES HAVE BEEN CALCULATED ASSUMING TOTAL BELT PULL TO BE THREE TIMES THE EFFECTIVE PULL i.e. $B_m = \frac{HP \times 33000 \times 12 \times C \times 3}{RPM \times \pi \times D}$ $T_m = \frac{HP \times 63000}{RPM}$.

EQUIVALENT TWISTING MOMENT $= B_m + \sqrt{B_m^2 + T_m^2} = T_{eq.}$

AS Z FOR TWISTING $= \frac{\pi D^3}{16}$. THE DIAMETER AT THE SECTION $= \sqrt[3]{\frac{T_{eq.} \times 16}{\pi \times STRESS}}$.

PRODUCT ENGINEERING

Chart for Two-Bearing Shafts of Uniform Strength

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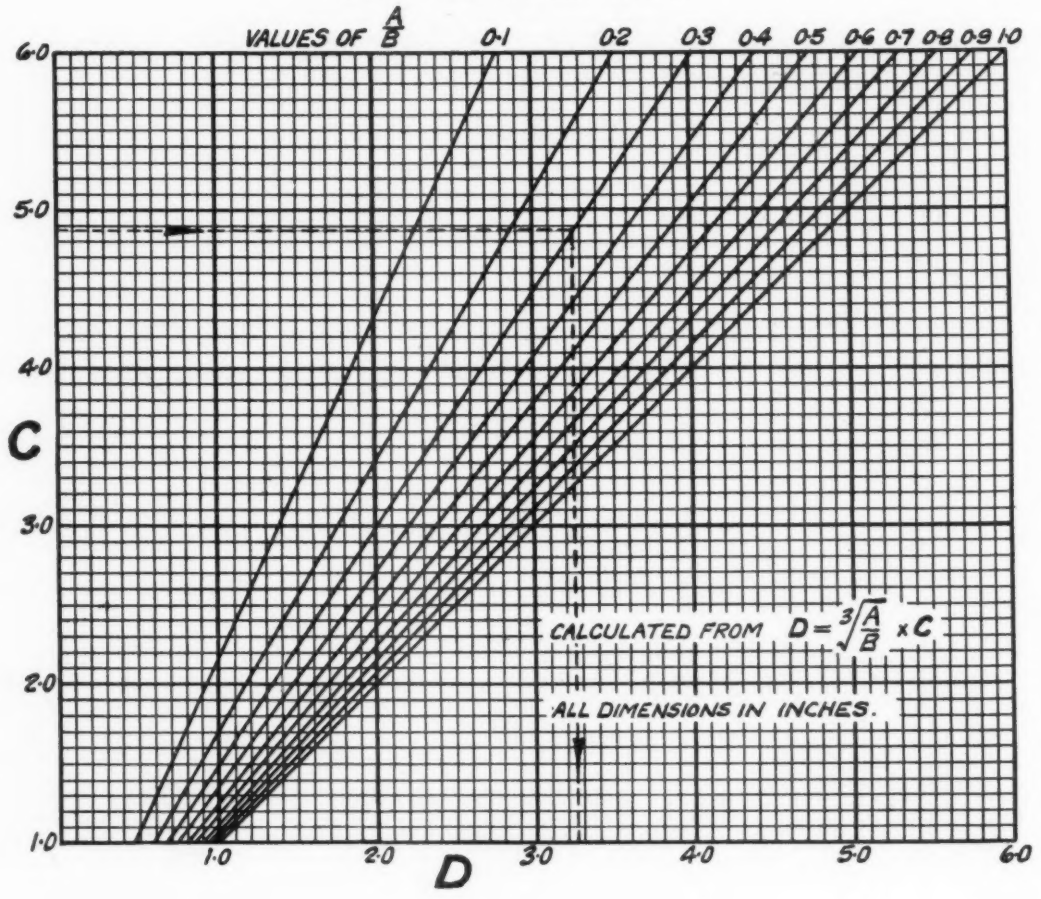

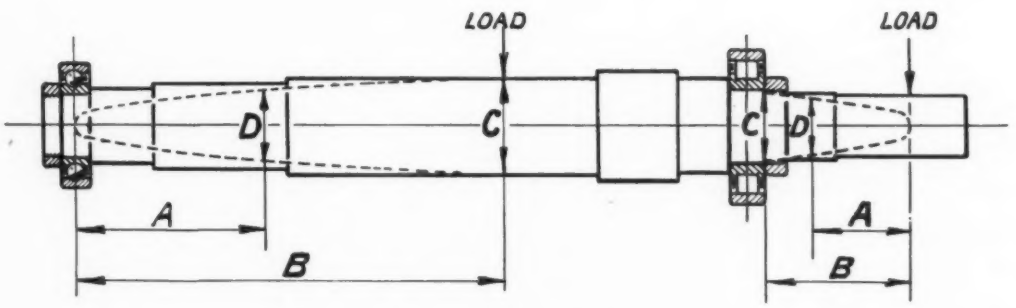

IN DESIGNING A SHAFT WITH TWO BEARINGS THE DIAMETER AT THE POINT BETWEEN THE BEARINGS WHERE THE LOAD OR RESULTANT OF LOADS IS APPLIED IS CALCULATED FROM CONSIDERATIONS OF DEFLECTION OR STRESS FROM THE CHART THE MINIMUM DIAMETER AT ANY OTHER POINT A DISTANCE A FROM THE CENTRE-LINE OF THE BEARING CAN BE FOUND.

IN THE CASE OF A SHAFT EXTENSION THE DIAMETER AT THE BEARING IS CALCULATED AND THE CHART GIVES THE MINIMUM DIAMETER AT ANY OTHER POINT A DISTANCE A FROM THE LOAD.

THESE "MINIMUM DIAMETERS" ARE SHOWN PLOTTED ON THE SHAFT THE POINTS FORMING A CURVE. IT WILL BE APPARENT THAT THE SECTION OF THE SHAFT AT THE INSIDE NECK OF THE BEARING OR AT THE LOAD MUST BE SUFFICIENT TO TAKE CARE OF SHEAR AND TWISTING MOMENT.

EXAMPLE — SHOWN BY DOTTED LINE — $A = 4\frac{1}{2}'' : B = 15'' : C = 4\frac{7}{8} : D = 3{\cdot}26''$ FROM THE CHART.

Contributed by C. S. Donaldson, Bradford, England

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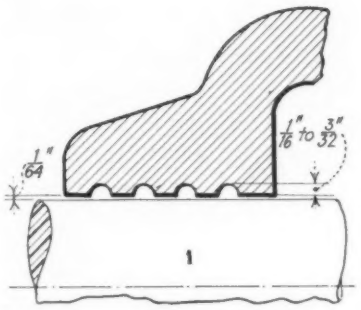
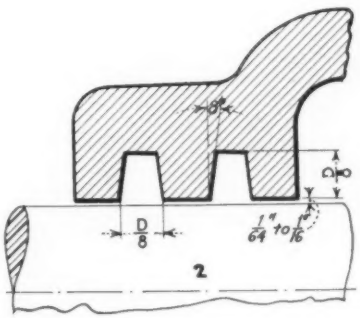
Seals for Shaft Housings and Bearings

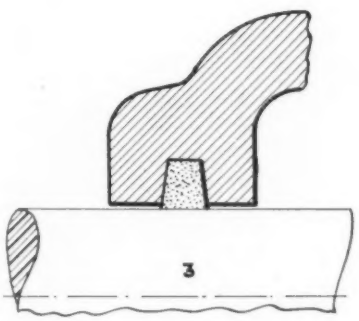
By L. L. LEACH
Engineering Department, Fuller-Lehigh Company



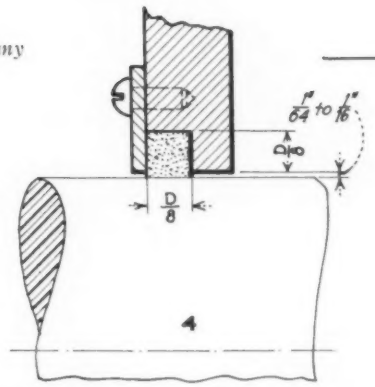
For grease lubrication, the half-round groove is used frequently, the effectiveness of the seal increasing with the number of grooves, of which there should be at least two



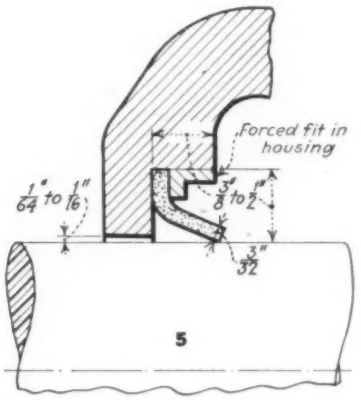
Sometimes this type is used without sealing rings



Usually only one groove with a cork, or felt ring is depended upon to perfect the seal. The tapered walls tend to press the sealing ring against the shaft



This design makes it easy to replace the cork or felt ring. In some instances the depth of the counter bore is doubled and two rings are used



One method of applying a simple leather seal

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In this group of typical seals will be found designs suitable for three general purposes: (1) To retain lubricant; (2) To keep out foreign matter; (3) To prevent the leakage of liquids or gases through the clearance space between the rotating shaft and its housing. A few of the designs shown are the patented products of specialties manufacturers, as indicated by the caption

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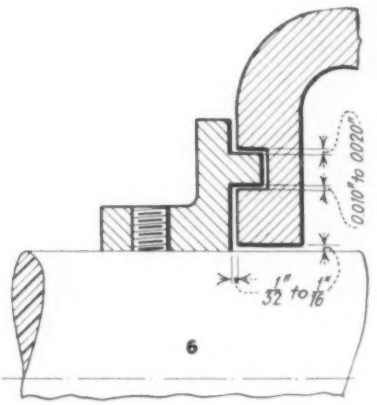
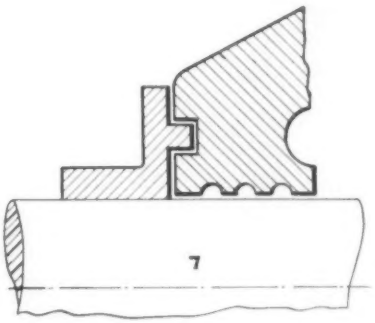
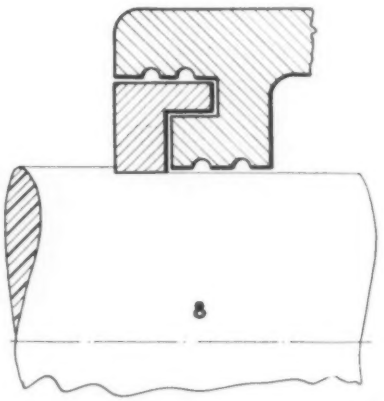


A simple design of labyrinth seal. Centrifugal force prevents the entrance of foreign particles while grease or oil lubricant on the shaft is thrown outward, thus filling the labyrinth opening





Labyrinth and groove seals can be combined for greater effectiveness

Seals for Shaft Housings and Bearings

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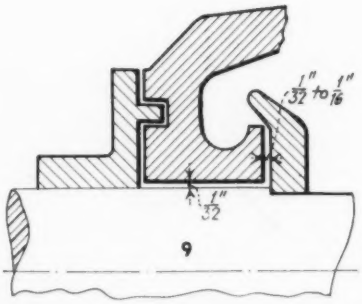
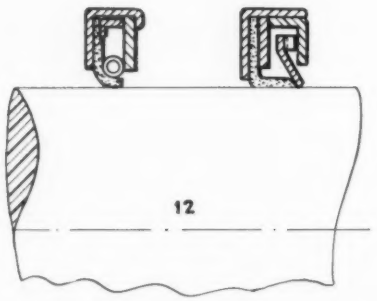


Addition of a slinger helps materially to prevent liquids finding their way through the seal



Left—Chicago Rawhide Company seal. Right—Gits Brothers Manufacturing Company. They can be used for sealing in either direction, the spring maintaining pressure between the leather and the shaft

Continuing with the subject of devices related to rotating shafts, the April number of Product Engineering will feature two pages of typical rigid shaft-couplings including both light-duty and heavy-duty applications

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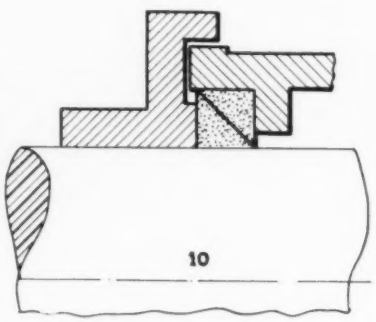
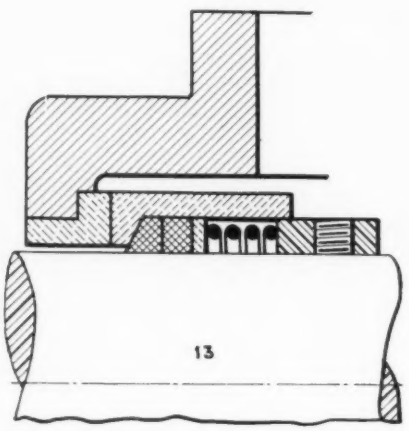
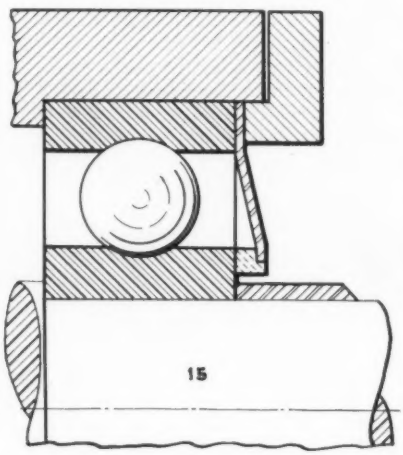


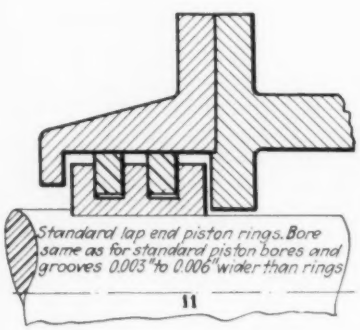
For slow speeds, two cork rings mounted as shown can be used. The set collar is sometimes counterbored and two small springs placed in the counterbore with a covering washer that bears against the sealing ring



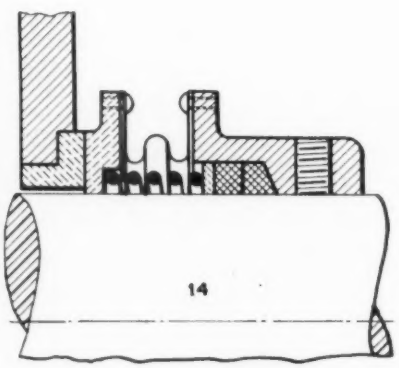
Cooke type seal that embodies the patented principle of maintaining contact between the stationary and moving surfaces



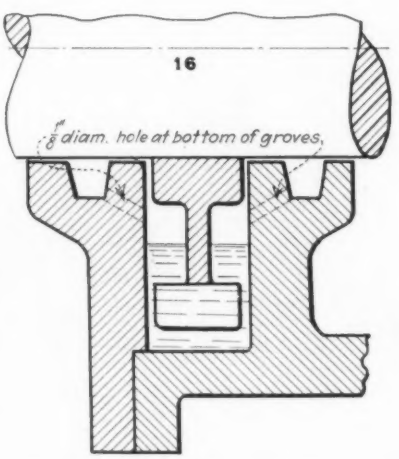
An effective ball or roller bearing seal



The common labyrinth shaft seal



Another application of the Cooke seal. Metal bellows permit relative movement



Illustrating the principle of the water seal

Differential Planetary Gearing

Direct Calculation for Required Numbers of Teeth

By L. S. MICHAEL

In the November, 1931, number of *Product Engineering* the author derived in detail a method for calculating directly the numbers of teeth for one type of differential planetary gearing. In this article, similar equations are given for other usual types of such gear trains

COMPACTNESS is normally one of the requirements for a gear train, and it is therefore essential that minimum numbers of teeth be used for the gears that make up the unit. The comnon method is to determine the numbers of teeth by inspection and trial. However, by the use of the equations given here, the numbers of teeth can be calculated directly for the specified velocity ratio. As in all gear problems, the exact desired ratio might involve fractional numbers of teeth. There will always be slight errors when the results are decimal quantities, and it becomes necessary to substitute for them the nearest whole numbers of teeth.

Referring to the accompanying Fig. 1, A and B are the pitch circles of pinions fastened side by side on a common axis, Z, and mesh with the pitch circles C and D. The gear represented by D is fixed, while C is free to rotate about the axis O, which is common to both of these gears. The pinions rotate together upon their common axis Z, which in turn moves about O at a fixed radius OZ. Although the arm OZ and the wheel C rotate about the same center, their respective angular velocities are independent of each other except as determined by the differential gear train $ABCD$.

To obtain an expression for the relationship of these two angular velocities, let the speed reduction ratio be expressed by:

$$\frac{\text{Revolutions per min. of } OZ}{\text{Revolutions per min. of gear } C} = \frac{N_o}{N_c}$$

Since gear D is fixed, point X is the instantaneous center about which all points in the gear set AB tend to rotate. If member OZ rotates at a fixed speed about its center O, and the length O-Z is known, the instantaneous velocity and direction of point Z at any position in its path, may be determined as follows:

$$\text{Velocity}_{\,z} = 2\pi\,(OZ)\;\; N_o = V_z$$

Representing this velocity by the vector ZL_1 and since Z is also a point on the axis of pinions A and B, the velocity and direction of any point on the pitch diameters relative to D may be determined graphically by drawing lines perpendicular to XZ and extending to line XL_1.

Therefore, YL_2 represents the velocity and direction of the pitch point Y, and since A and C are in non-slipping contact at Y, YL_2 represents also the pitch velocity and direction of motion of gear set A and C relative to D.

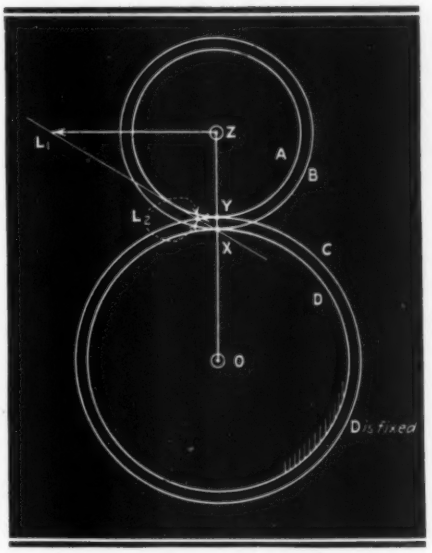


Fig. 1—Velocity diagram for obtaining the fundamental equation of the relation between speed ratio and numbers of teeth in uni-directional internal differential planetary gear trains

On this basis, and using the same method as applied in the above mentioned previous article, the following equation is obtained:

$$\frac{N_o}{N_c} = \frac{R_B\, R_C}{(R_B - R_A)\,(R_D + R_B)}$$

Multiplying numerator and denominator of the right side of this equation by $4\,S_1\,S_2$, and simplifying:

$$\frac{N_o}{N_c} = \frac{T_B\, T_C}{\left(\dfrac{T_B\, S_2}{S_1} - T_A\right)\left(T_D + T_B\right)} \qquad (1)$$

In this equation S_1 is the diametral pitch of gears B and D, and S_2 is that of gears A and C. For a given diametral pitch and length of arm OZ, the total number of teeth, $T_D + T_B$ can be calculated.

$$T_D + T_B = 2S_1\, OZ = M \qquad (2)$$

Also $$\left(T_C + T_A\right)\frac{S_1}{S_2} = M$$

or $$T_C + T_A = \frac{M\, S_2}{S_1} \qquad (2a)$$

Referring to the fundamental Equation 1 and to the accompanying figures, it can be seen that the smaller the quantity $\left(\dfrac{T_B\, S_2}{S_1} - T_A\right)$ becomes, the greater will be the ratio $\dfrac{N_O}{N_C}$. The

minimum difference for this expression is, of course, the minimum difference in whole numbers of teeth, that is, one tooth. Therefore:

$$\frac{T_B S_2}{S_1} - T_A = 1 \qquad (3)$$

The quantity $T_C - \dfrac{T_D S_2}{S_1}$

is always equal to the quantity' $(T_B - T_A)$, hence:

$$\frac{T_B S_2}{S_1} - T_A = T_C - \frac{T_D S_2}{S_1} = 1 \qquad (3a)$$

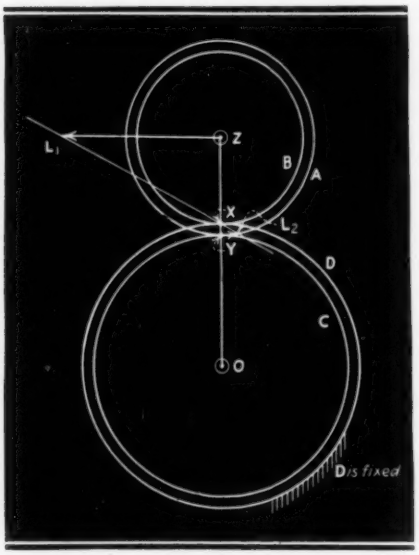


Fig. 2—For reversed rotation, the fixed gear mates with the smaller pinion and the direction of the velocity of point *Y* is opposite that of point *Z*

Substituting Equations 2 and 3 in Equation 1, we have:

$$\frac{N_O}{N_C} = \frac{T_B T_C}{M} \qquad (4)$$

or $$T_B T_C = \frac{N_O}{N_C} M$$

Adding Equations 2a and 3, we get:

$$\frac{T_B S_2}{S_1} + T_C = \frac{MS_2}{S_1} + 1$$

Multiplying by T_C and $\dfrac{S_1}{S_2}$,

$$T_B T_C + T_C^2 \frac{S_1}{S_2} = M + \frac{S_1}{S_2}$$

Substituting this in Equation 4, and simplifying:

$$\frac{S_1}{S_2} T_C^2 - T_C \left(M + \frac{S_1}{S_2} \right) + \frac{N_O}{N_C} M = 0 \qquad (5)$$

In solving a practical problem, the procedure becomes comparatively simple. The first step is to obtain a working constant M. From the conditions imposed, a value is assigned to OZ, knowing that it will be approximately one-third the diameter of the outside circle swept by the planet gear B. Load conditions indicate the most practical diametral pitch to be used, and the desired reduction ratio $\dfrac{N_O}{N_C}$ is known. The quantity M is determined as shown by Equation 2, by the values of S and OZ selected. With M and N_O/N_C known, the values are substituted in Equation 5, which is then solved to obtain the value of T_C. Then Equation 4a gives the value of T_B, and Equations 3 and 3a will determine the values of T_C and T_D respectively.

Having determined the required numbers of teeth for all four gears, and since all of them are of the same diametral pitch, the latter may be altered at will without affecting the speed ratio. In this way, the required over-all dimensions can be procured readily, or the pitch of the gear teeth increased in order to meet strength or wear conditions.

As an example, let it be assumed that a 20 to 1 reduction is desired and that:

$OZ = 6$ in.

$S = 8$

$T_A - T_B = 1$

From Equation 2,

$M = 2S\ (OZ) = 96$

Substituting in Equation 5

$T_C^2 - 95\ T_C + 1920 = 0$

Solving this equation,

$T_C = 69.25$, or 27.75

Hence, the value of T_C may be taken as either 69 or 28 teeth. Both of these two solutions are correct.

In the gear system just described, the direction of the driven gear C is the same as that of the driving shaft OZ. When it is necessary to have gear C rotate in the opposite direction, an arrangement as shown in Fig. 2 is used. The gear D is made larger than the gear C, but remains the fixed element. Pinion A is then larger than B, and the expression for the difference in number of teeth changes from $T_B - T_A$ to $T_A - T_B$.

The pinion set AB rotating about the axis X in Fig. 2 causes the pitch point Y on the gear C to move in the opposite direction from which OZ is rotating.

Following the same procedure as set forth for the previous case, the following quadratic equation is obtained:

$$\frac{S_1}{S_2} T_C^2 - T_C \left(M - \frac{S_1}{S_2} \right) + \frac{N_O}{N_C} M = 0$$

The procedure for obtaining the solution to a problem of this type is identical with that presented in the first case, and therefore will not be repeated here.

For the type of differential planetary gearing showin in Fig. 3, the same general method of calculation may be employed. By the same general method we get

$$\frac{N_O}{N_C} = \frac{T_B T_C}{\left(T_C - T_A \right) \left(T_B + T_A \dfrac{S_1}{S_2} \right)} \qquad (1)$$

It is evident from the figure that

$$OY - R_C = R_D + R_B + R_A$$

From this last equation we get:

$$T_D S_2 = T_C S_1 - (T_B S_2 + T_A S_1) \qquad (2)$$

From the nature of the mechanism, we may use any value for T_A or T_B ranging from the lowest practical minimum of about seven teeth to as high a reasonable figure as the conditions of the problem will permit.

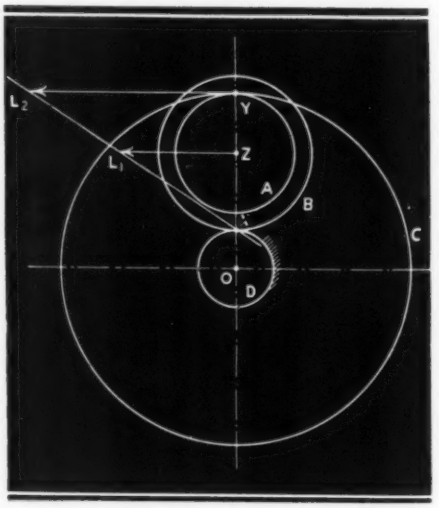


Fig. 3—Gear *C* will always rotate faster than arm *OZ*, and in the same direction, hence the unit may be used as either a speed reducer or speed increaser, depending upon whether the gear or the arm is driven

Therefore, while the assigned value of $\left(T_A \dfrac{S_1}{S_2} + T_B \right)$ can never be less

than 14, it may and in most cases should be much greater.

$$T_A\frac{S_1}{S_2} + T_B \gtrless 14 \qquad (3)$$

If the engineer cannot decide upon a value for $T_A + T_B$ he may experiment with a number of values over a wide range in order to find the most satisfactory combination. The method of calculating is easy and direct and the resulting ratio will always be within a few percent of that desired.

Because of algebraic limitations it must be remembered here that if we are to avoid obtaining an imaginary (mechanically impossible) solution to our problem the value of $\frac{N_o}{N_c}\left(T_A\frac{S_1}{S_2} + T_B\right)$ must be greater than T_B by at least 1 and preferably 2, 3, or 4 teeth. This small integral difference will be designated as M.

Expressed as an equation,

$$\frac{N_o}{N_c}\left(T_A\frac{S_1}{S_2} + T_B\right) - T_B = M \qquad (4)$$

Under some conditions the solution of this equation will show T_A to be greater than T_B. The solution of the problem will, however, be unaffected.

As an example, assume it is desired to obtain an increased speed ratio of 1.58 to 1, pitches S_1 and S_2 to be equal.

$$\frac{N_o}{N_c} = \frac{1}{1.56} = \frac{.632}{1}$$

Let $T_B + T_A$ equal some integer greater than 14, which when multiplied by N_O/N_C will be a whole number.

Let $T_B + T_A = 19$
(because $0.632 \times 19 = 12$)
Let $M = 2$
then $0.632\ (19) - T_B = 2$

$$T_B = 10$$

Therefore,

$$T_A = 9$$

Note that T_B is greater than T_A. Substitute in Equation (1)

$$\frac{0.632}{1} = \frac{10\ T_c}{(T_c - 9)\ (19)}$$

$$12\ T_c - 108 = 10\ T_c$$

$$T_c = 54$$

$$T_p = 54 - 19 = 35$$

(from Equation (2)

Check in Equation (1)

$$\frac{N_o}{N_c} = \frac{10\times54}{45\times19} = \frac{540}{855} = \frac{0.632}{1}$$

If two different pitches are to be used, they must be selected before proceeding with the problem in order that the value of $\frac{S_1}{S_2}$ may be determined. If fractional numbers of teeth are obtained, select the next greater or smaller whole number.

Pointers in Designing Aluminum Alloy Castings

By H. J. Rowe

Technical Control and Development Section, Aluminum Company of America

SUCCESS or failure in producing aluminum alloy castings begins on the designer's drawing board. Success or failure is measured by the ultimate quality of the castings and the cost of their production.

All castings are designed with the idea of answering a certain purpose or performing a given function. The designer, of course, must keep these requirements foremost in mind in the design of every casting. This does not necessarily mean that only one design will fit each particular casting either from the designer's or the foundry's standpoint. But there is generally one that is best.

If the designer is familiar with those factors which make for the best foundry practice, he has little difficulty in submitting the most desirable design to the foundry.

Like other alloys those of aluminum possess certain inherent properties which have a direct bearing on their foundry characteristics. Consideration of these properties during the design of a casting will aid the foundryman.

The low specific gravity of aluminum alloys is of considerable advantage in that it reduces mold pressures, allowing lighter sand ramming and smaller mold equipment. It is, however, a distinct disadvantage in that it makes it harder for aluminum alloys to rid themselves of oxide inclusions or drive off mold gases as readily as the heavier metals. The designer of aluminum castings, therefore, should avoid calling for thin ribs and fins. Also. to aid in the elimination of mold gases, particularly in cored castings, venting considerations are very necessary in the design of such castings.

Observations of the second characteristic, hot shortness, will prevent considerable foundry scrap loss from cracks. Such cracks occur when the casting, during solidification, encounters excessive resistance to normal contraction, and especially while in the "hot short" state. The maintaining of uniform casting sections, the use of generous fillets, and the elimination of "box like" sections are beneficial in reducing the effects of hot shortness.

The relatively high crystallization shrinkage of aluminum alloys makes necessary suitable feeding of castings during solidification. This is generally accomplished through the generous use of risers, so placed as to feed the casting progressively as it solidifies.

Like all other metals aluminum alloys possess a linear shrinkage while cooling in the solid state. Although the shrinkage varies slightly, depending on the size and shape of the casting, the designer and pattern maker can make the necessary allowances to compensate for it in the final casting.

Numerous aluminum alloys are in general use at the present time. For sand castings, the designer and foundryman have a choice of a number of alloys, each possessing a particular combination of properties to fulfill certain requirements in a casting. The selection of the proper alloy, based on such considerations as mechanical properties, resistance to corrosion, machinability, casting characteristics, etc., is very essential for ultimate results.

The designer's desire for maximum physical properties should not influence his selection of an alloy without first considering the casting characteristics necessary for economical foundry production. From this standpoint it may sometimes be necessary to do without some desirable minor property in a casting of a particular design, in order to aid the foundry.

Abstracted from a paper presented before the American Foundrymen's Association, Philadelphia, Jan. 13.

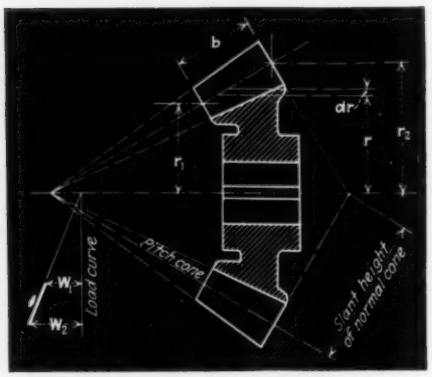
COMMENT and SUGGESTION

Strength of Bevel Gear Teeth

By James I. Clower

IN the design of bevel gears as set forth in the Reference-Book Sheet in a recent number of *Product Engineering,* there are a few additional points that should be emphasized.

In bevel gears, the load per inch of face on the tooth varies from one end of the tooth to the other, being a maximum at the outer end of the tooth and a minimum at the inner end. It can be demonstrated by the principles of mechanics that the load per inch of face at any point along the tooth is directly proportional to the radius from the center of the supporting shaft. Hence, the load varies uniformly from the outer end of the tooth to the inner end, the mean value being at the middle of the tooth. Therefore, a spur gear, having the same width of face, and teeth of the same form and pitch, as those at the mean section of the bevel gear, will have the same strength as the bevel-gear tooth.



Distribution of load along the tooth of a bevel gear

Under load, the action of a bevel-gear tooth is identical with that of a spur-gear tooth, and the pitch may be determined in a similar manner, basing the selected pitch upon the maximum load per inch of face.

Referring to the figure, let:

w_1 = load per in. of face in lb. at r_1

w_2 = load per in. of face in lb. at r_2

w = load per in. of face in lb. at any radius r

δr = infinitesimal increment of radius r.

The width of face corresponding to δr will then be:

$$\delta r = \delta r \times \frac{b}{r_2 - r_1}.$$

The load on this part of the tooth will be:

$$w \times \delta r \times \frac{b}{r_2 - r_1}.$$

The torque δT which this load exerts, will be:

$$\delta T = \delta w \times r = w \times r \times \delta r \frac{b}{r_2 - r_1}$$

Since the load per inch of face at any point is directly proportional to the distance from the axis of rotation, we have:

$$\frac{w}{w_2} = \frac{r}{r_2} \text{ or } w = w_2 \frac{r}{r_2}.$$

Substituting this value of w in the above equation and integrating between the limits of r_1 and r_2, we have:

$$T = \int_{r_1}^{r_2} w_2 \frac{r}{r_2} r \delta r \frac{b}{r_2 - r_1}$$

$$= \frac{w_2 b}{r_2 (r_2 - r_1)} \times \frac{r_2^3 - r_1^3}{3}$$

If we let w_e represent the load per inch of face on a spur gear having a diameter equal to $2r_2$, and a face width b, and transmitting the same torque as the bevel gear, we have for the equivalent spur gear, the total torque

$$T = w_e \times b \times r_2 = \frac{w_2 b}{r_2 (r_2 - r_1)} \frac{(r_2^3 - r_1^3)}{3},$$

$$\frac{w_2}{w_e} = \frac{3 r_2^2 (r_2 - r_1)}{(r_2^3 - r_1^3)} = k.$$

Interpreting the above equation, it is evident that the maximum load per inch of face on a bevel-gear tooth is k times that produced on a tooth of a spur gear of the same diameter and width of face and transmitting the same torque. The determination of a suitable pitch for a bevel gear consists therefore of considering it as a spur gear transmitting k times the actual torque.

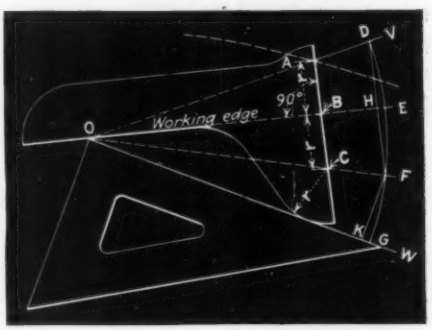
It should be borne in mind that the form or outline of a bevel-gear tooth is identical to that of a spur-gear tooth contained on a gear whose diameter is equal to twice the slant height of the normal cone. The corresponding spur gear is usually designated as the formative gear. The value of y in the Lewis equation should be based upon the number of teeth in the formative gear.

Angle Trisector

By Clinton C. Hubbell

ANOTHER simple tool for trisecting any angle is shown in the accompanying figure. It may be constructed any size but the following relations must be maintained. The working edge must be straight and if prolonged pass through mark B. Secondly, the end carrying the marks A, B and C must be at right angles to the straight working edge, and the distance between B and C must equal that between A and B. The point C is the center for swinging the arc that forms the toe, as indicated.

In using the trisector, a triangle is



By means of this simple instrument any angle can be trisected readily, as indicated

placed on the side *O-W* of the given angel *V O W*, with the corner of the triangle coinciding with the vertex *O* of the angle to be trisected. The trisector is placed as shown in the figure, being adjusted until the mark *A* falls on the line*O-V*. The balance of the procedure is evident from the figure, *O D* being any radius.

Threaded Pivots and Bearings

By Arthur Pestel
Consulting Engineer

TO support machine elements on threaded instead of smooth surfaced pivots and bearings is quite an old practice, yet very little applied by the

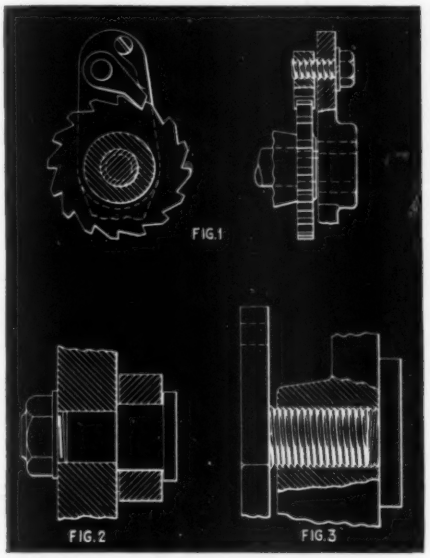


Fig. 1—Pawl with threaded pivot, a use where the slight lateral motion causes no trouble. Fig. 2—Conventional pivot. Fig. 3—Link on a threaded bearing

the machine designer. It seems that in many instances, when designing new devices, especially small machines and instruments, considerable time and effort could be saved, if applying a threaded pivot or bearing for the support of levers, pawls, links and the like, especially where the application may cause certain difficulties relative to the requirements of available space, or adjustability.

In Fig. 1 is shown a pawl riding on a threaded pivot in form of a screw held in the supporting and movable arm of the pawl. During operation the pawl has a slight lateral motion on the return stroke of the arm, but not at its forward motion and while under pressure. Therefore, no objection could possibly be raised to having the pivot threaded, provided it is sufficiently strong and rigid.

It is true, of course, that the shouldered pivot, held tight against the arm, shown in Fig. 2 furnishes a more rigid design. It should be applied where the transmission of heavy loads is required. But there are also numerous instances where the designer is privileged to disregard this conventional method of supporting pawls or levers and can make use of the threaded pivot or bearing. Advantages of the latter are that the thread furnishes a larger bearing surface within a shorter space than a straight cylinder, a characteristic which is valuable where little space is available. A further advantage is that in most instances the pivot may be a standard screw, so that the cost of manufacture can be reduced. Another advantage is that the pawl may easily be set into alignment with the teeth of the ratchet wheel, or be laterally displaced from the arm to suit certain desirable conditions. Still another is the small space required.

Fig. 3 shows a link supported in a threaded bearing. This design has the same advantages as those pointed out above, and proves to be of value whenever a blind bearing hole is to be used. The link is easy to assemble and will not shift its position laterally and drop out.

If plate or wall thickness is small, so that a few threads only are available, the diameter of the threaded bearing can be made large enough, say 2 to 3 in., to eliminate play.

A straight Briggs Standard Pipe Thread up to 4 in. diam. or a gas fixture thread with a standard of 27

DEFLECTIONS

NITRIDED VALVES?

It has recently been discovered that chlorine compounds exposed to nitrided steel at high temperatures will de-nitride and soften the steel. This answers immediately the question why nitrided engine valves become pitted when antiknock gasolines are used. It is a good point to remember in chemical machinery design, also.

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ONLY FIVE YEARS

Even the casual reader of Herbert Chase's article on automotive developments as exemplified at the New York Automobile Show will agree that automotive progress has been steady, continuous and far-reaching. Car users of today laugh at what was considered "the last word" in the cars of 1927. But compare automotive development—or airplane development—with developments in railroad transportation. Some improvements have been made, but they are woefully few. Railroad equipment today is substantially the same as that of five years ago. Why? Are these transportation systems so old and hoary that five years is too short a period for design improvement, or are they, in the words of one railroad chief engineer, "conservative, ultra-conservative — in fact, almost leaning backward"?

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TOO MUCH "BEEF"

The old mechanic's saying, "Be on the safe side and put in a little extra 'beef' in the castings," doesn't work in flat-spring design. Excess metal in a spring is very undesirable, according to Wallace-Barnes engineers, and this excess metal gives a reduced, rather than an increased, factor of safety. Even after the right thickness has been calculated, cantilever springs should be tapered.

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MAGNESIUM SHEETS HOLD PROMISE

Experiments with sheet magnesium for light structures point to possibilities of its extended use. One designer feels that the fact that a sheet of magnesium can be approximately fifty per cent thicker than "dural" and yet weigh no more means much in considering the general rigidity of a built-up structure. It can be spot welded without damaging the metal, and the possibilities of lowered construction costs seem assured. The thicker sheets make a stiff structure.

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COLOR SPEAKS

We are running a series of articles on the application of color to various products. In fact, one will be found in this issue. Lest some be skeptical of the power of color, here is a case in point. W. Pegler, sportswriter for the *Evening Post*, New York, has four typewriters, one red, one blue, one black, and one of lighter color. When he is of a funereal turn of mind, particularly after viewing one of the more recent prizefights, he prefers doing his stories on either his blue or his black typewriter. However, when things are going better and he wishes to effervesce in a lighter vein, he uses the red or the lighter colored machine. This may sound like hokum, but Mr. Pegler feels that the colors help him to inject the proper kind of atmosphere into his stories.

threads per in. for all nominal sizes of taps up to 1 in. all purchasable on the market, furnish a convenient selection of threads for this kind of pivot and bearing.

In Answer to Mr. Shaw

By L. S. Michael

TO the alert Mr. Shaw, my sincere thanks for calling attention to a careless error. Equation 1 of my article in the November number of *Product Engineering* is applicable only when the pitches of the various gears of the train are all equal, which accounts for the error in the last example.

The equations presented, however, can be modified to take care of the conditions wherein different diametral pitches are used. The derivation of such an equation is as follows:

$$\frac{N_o}{N_c} = \frac{R_B R_C}{(R_B - R_A)\ (R_D - R_C)}$$

In the above equation,

$$R_B = \frac{T_B}{2S_1}$$

$$R_C = \frac{T_C}{2S_2}$$

$$R_A = \frac{T_A}{2S_2}$$

$$R_D = \frac{T_D}{2S_1}$$

Hence,

$$\frac{N_o}{N_c} = \frac{R_B\ R_C}{\left(\frac{T_B}{2S_2} - \frac{T_A}{2S_1}\right)\left(\frac{T_D - T_B}{2S_1}\right)}$$

$$\times \frac{4S_1 S_2}{4S_1 S_2} = \frac{T_B\ T_C}{(2T_B S_2 - 2T_A S_1)\ (T_D - T_B)}$$

$$\frac{N_o}{N_c} = \frac{T_B\ T_C}{\left(\frac{T_B S_2}{S_1} - T_A\right)\left(T_D - T_B\right)} \quad (1)$$

This last is a revision of Equation 1 given in the above-mentioned article. It is applicable when different diametral pitches are used for the two pairs of gears. To obtain a minimum differential diameter between gears *A* and *B*, the value of the left-hand member of the denominator of the above equation should be made as small as possible. For this condition, let:

$$\frac{T_B S_2}{S_1} - T_A = 1 \quad (2)$$

Also, let $T_D - T_B$ be a minimum value, Δ

For the values that may be used for this quantity Δ, see Kent's Handbook. Also, as set forth in the published article:

$$\frac{T_C - T_A}{S_2} = \frac{T_D - T_B}{S_1} = \frac{\Delta}{S_1}, \text{ and}$$

$$T_C - T_A = \frac{S_2}{S_1}\Delta$$

Subtracting the above Equation 2:

$$T_C - \frac{S_2}{S_1} T_B = \frac{S_2}{S_1}\Delta - 1$$

$$T_B = \frac{S_1}{S_2} T_C - \Delta + \frac{\Delta_1}{S_2}$$

Substituting this quantity in the above Equation 1:

$$\frac{N_O}{N_C} = T_C \frac{\left(\frac{S_1}{S_2} T_C - \Delta + \frac{S_1}{S_2}\right)}{1 \times \Delta}$$

$$\frac{S_1}{S_2} T_C^2 - T_C\left(\Delta - \frac{S_1}{S_2}\right) - \frac{N_o}{N_c}\Delta = 0$$

Since all of the values in this quadratic equation are assigned, except that of T_C, the equation may be solved as an affected quadratic. It will be noted that when $S_1 = S_2$, the expression becomes identical with Equation 10 presented in the original article.

Designing "Jig-Jogs"

By Lewis N. Stewart

Special Machinery Designer, Greenlee Bros. & Company

MANY of the engineers engaged in product engineering are capable of doing more and better work than their managers or boards of directors will permit them to do. It often occurs that the engineer is actually sidetracked in the development work, but when the product then goes wrong, he has to stand for the blame. Some old fogy known to his organization as a genius is permitted to spend thousands of dollars in developing a new model by the cut and try method. The company's executives witness the tests and vote to put the product into production. The advertising manager (who is seldom an engineer) places a rush order for some circulars. Some of these circulars are amusing if not comical. Very often the line, "In accordance with the high standards of engineering maintained only by the Smith Jones Engineers," is seen in these circulars. The first lot of ten is ordered and everyone dreams of the increased business that the new "Model 46-B" will bring in.

Inspired by this idea the shop gets out patterns in record time. Everything goes along fine. All parts for the first lot of ten are about half finished when a salesman wires the first order. This lot is now put on the rush list and some departments may be asked to work overtime. Assembling starts on the first unit, and here is where the fun starts. Owing to the rush the parts were not held to rigid inspection, the wrong heat-treatment has been specified on some of the drawings, (that draftsman was not an engineer, he was only a draftsman). On a certain sprocket drawing the note, "Ream for No. 4 taper pin in assembly" is found, but the assembly foreman finds that the shaft which this sprocket is to be mounted

The jig-jog

on is "Hardened to approx. 75 Scler." Of course the checker (who is not an engineer) is to blame for that.

Well, let's say that the Model 46-B is finished and arrives at the customer's plant. It is discovered that the builder did not supply the wrenches for adjusting those gadgets. Then the guards are not consistent with the safety code. The customer changes these. Then the customer informs the salesman that it has long since been the practice to install force-feed lubrication, and asks that the

manufacturer furnish same. The representative makes notes of the things that the customer had to do to the Model 46-B in order to put it to work in his plant, and at another board meeting it is decided that if all these changes are made together with some ideas that have been suggested by the different department heads in the shop, the price will have to be raised.

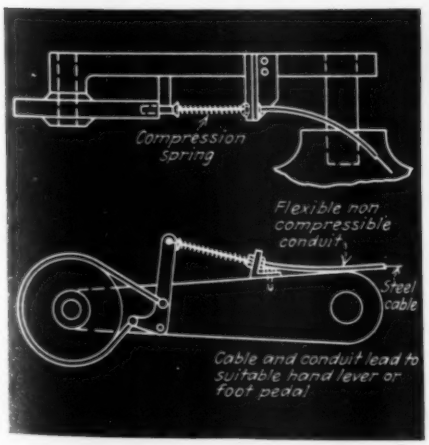
At this stage they call on the engineer to redesign the product and put it in commercial form. He must not, however, change the drive because it has been decided that certain parts used on the drive of the 23-Q machine are to be used. The automatic control and safety stop devices cannot be changed because the president of the company thinks that it is the cleverest device he ever saw and should be a good selling point. The engineer cannot change the base because elaborate patterns have been made. The clutch is not of sufficient capacity but because of limited space a larger one cannot be used without making changes in the gear center distance of the drive shaft, and this would affect some other parts. There is not much that the engineer can do now.

My 3-year-old son once stacked up a lot of his toys and playthings in a very peculiar pile. I watched him as he picked and piled the toys. Finally he asked me to come and see what he had made. After admiring his work I asked him what he called it, and he answered, "A jig jog." That's what some machines are.

How It Can Be Done

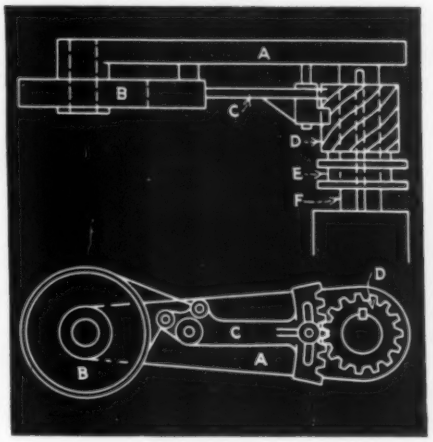
FOLLOWING are a few of the solutions to Mr. Covington's problem that appeared in the February number under the title "How Can It Be Done?" Many additional designs have been submitted, a few of which will appear in the next number.

BRUCE HEEBINK


Compression spring
Flexible non compressible conduit
Steel cable
Cable and conduit lead to suitable hand lever or foot pedal

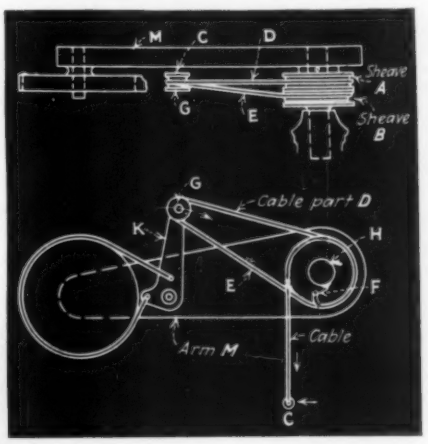
The accompanying sketch shows a simple device for actuating the brake. The cable and conduit should be readily obtainable. A similar device is used on the Chevrolet front-wheel brakes at the present time.

SOLUTION BY R. A. PITMAN
Earle Gear & Machine Company



To actuate the brake B, regardless of the location of the arm A, provide a sleeve D and an arm C, as shown in the accompanying illustration. The arm C has spirally cut teeth, preferably at 45 deg. The sleeve D is keyed to the shaft F and hence retains fixed relationship of all parts during rotation of the arm A.

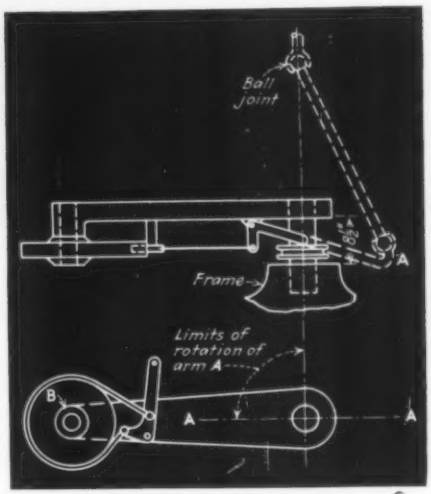
SOLUTION BY HERMANN HILL
Research Engineer,
Syracuse Washing Machine Corporation



The scheme I am illustrating permits the actuation of the band brake by pulling on the cable C, which is connected to any suitable lever. In this hook-up it is possible to actuate the band brake during the actual movement of the arm.

The small sheave A is keyed to the shaft, while the sheave B is free to revolve. The light wire cable is anchored at F on sheave A, and is wound over a small pulley on the brake lever, as indicated. From there, the cable winds once around sheave B and ends at eyepiece C. When the arm M is rotated upwards, the cable unwinds on sheave A and an equal amount of cable winds up on sheave B, thereby maintaining G a constant distance from shaft H. When C is pulled, sheave B rotates with the cable and pulls, thereby applying the brake.

SOLUTION BY GEORGE W. DUNHAM
Consulting Engineer



Two simple methods suggest themselves. One method is to fulcrum a bell crank on the side of the brake supporting arm and to provide a sliding flanged collar on the shaft, which can be actuated by a forked lever mounted on the frame, as indicated.

A variation of this design would be to provide a similar ball crank extending it to a convenient point A beyond the supporting shaft. This construction is shown by the dashed lines. Connect this lever with the controlling lever by means of a pull or push rod terminating in ball joints at each end, the actuated end to be on the center line of the supporting shaft.

"What Is Color?" Copyright

INADVERTENTLY the copyright announcement was omitted from the article on "What Is Color?" in the February number of *Product Engineering*. This should have read:

Published through the courtesy of the Universal Color Standards, Inc., Baltimore, Maryland, exclusive representatives for the Munsell Color System by special permission of the copyright owners.

NEWS

Metal Congress, Oil Burner Show, Applied Mechanics Division—A.S.T.M. on Rubber—A.F.A. on Casting Shrinkage—A.S.A. Projects

THE week of October 3, two weeks later than usual, and the city of Buffalo have been selected for the 14th annual National Metal Congress and Exposition. Afternoon technical sessions of the Congress will be held at the 174th Regimental Armory, a huge building which offers 105,000 sq.ft. of exhibit space free from pillars and with every exposition facility.

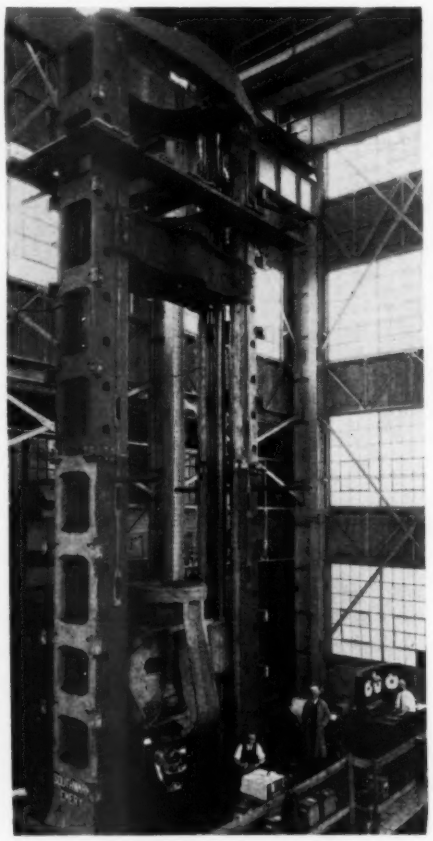
Heretofore the annual Oil Burner Show has been open only to members of the American Oil Burner Association. Directors have, however, decided to enlarge the 9th annual show, to be held in Boston, April 11 to 16, by waiving the membership requirements for accessory or associate exhibition. The privilege of exhibiting oil burners will, however, be confined to members as usual. The association will hold its convention in the Hotel Statler during the week of the show. An attendance of 10,000 is expected.

The Second National Meeting of the Applied Mechanics Division, A.S.M.E., will be held in New Haven, Conn., June 23-25, simultaneous with that of the American Physical Society. Some joint sessions will probably be held. PROF. G. B. PEGRAM is the new chairman of the division, succeeding A. L. KIMBALL, who retired to an associate membership on the committee. PROF. E. O. WATERS of Yale has been appointed to the executive committee to succeed Mr. Kimball.

The Third Regional Meeting of the American Society of Testing Materials is to be held in Cleveland, March 9, with sessions and a dinner in the Hotel Cleveland. A symposium on rubber is to be held in the morning and afternoon sessions.

At a recent meeting of the Southwest Road Show & School and the Western Tractor & Power Farm Equipment Show for 1932, it was decided to cancel both shows because of general conditions. They will be carried on in 1933 as usual, according to present plans.

American Foundrymen's Association and the National Bureau of Standards have been cooperating in a study of the shrinkage of metals during casting and the influence of such shrinkage on the production of sound castings. The work was reported in the January number of the Bureau of Standards Journal of Research. The present paper describes a method which has been developed for measuring the volume changes undergone by a metal or alloy with change in temperature as it cools from the liquid.



Southwark-Emery 4,000,000-lb. test machine for University of California, the largest built thus far. First tensile test was of an 8 1/16-in. steel bar that failed at 3,095,000 lb.

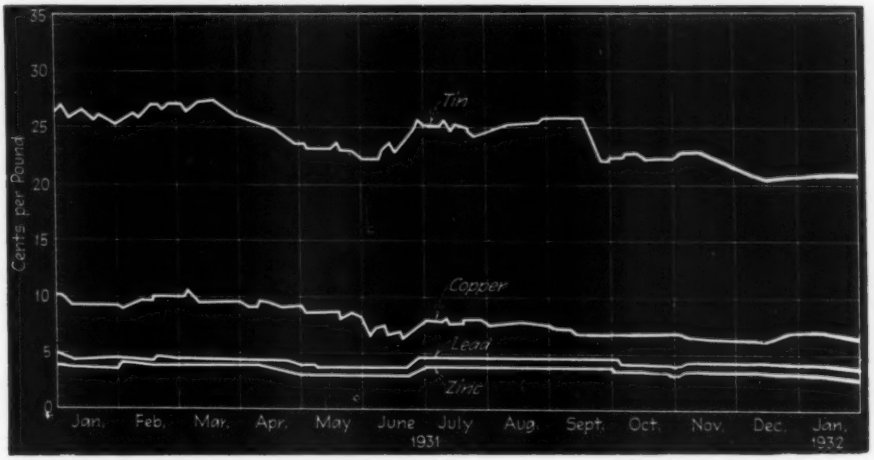
The American Standards Association has just reviewed mechanical engineering projects under its procedure. Committee B1, on Standardization and Unification of Screw Threads, has completed a survey on samples of threaded screws and bolts to determine present screw-thread practice and is now working on a similar survey of nuts. The sponsor bodies intend to publish a comprehensive summary of the measurements as soon as completed. Subcommittee 3 on Special Threads and the Twelve-Pitch Series has recommended the establishment of a series of 12-pitch threads with tolerances suitable for general-purpose application, tolerances on the nut threads to be given in accordance with Class 2 fit, and tolerances on the screws in accordance with Class 2 and Class 3 fits. This committee also recommended the setting up of a series of 8-pitch threads from 1 to 3 in.

A subcommittee on Wood Screws has been organized, which is proposing that the minor diameter of screws be made 65 per cent of the major diameter, with a permissible variation of plus or minus 4 per cent.

Committee B3, on Ball and Roller Bearings, has published an American Standard for single-row annular ball bearings and Recommended Practice for wide-type annular ball and roller bearings. It is now considering standardization of nomenclature for elements of annular and thrust ball bearings. Important is the development of a proposal concerning a series of standard tapered roller bearings comprising 21 light, 19 medium, and 18 heavy bearings ranging in bore from $\frac{3}{8}$ to $4\frac{1}{2}$ in., and meant to replace over 1,000 stock bearings now extensively used.

A revised draft of a proposed American Standard for Lathe Spindle Noses has been distributed to industry for criticism and comment, and the new types are under test.

Committee B6, on Standardization of Gears, has under consideration a proposal for Gearing Nomenclature applying to spur, helical, herringbone, bevel, and worm gears, adopted recently by the American Gear Manufacturers' Association, and includes a complete set of symbols for all elements having a dimensional value, and also a series of abbreviations. It will soon submit a proposed standard for Tooth Form of the $14\frac{1}{2}$-deg. and 20-deg. Full Depth Involute System, and is also developing a draft of a standard for herringbone gears and another on gear materials.



Metal Markets

COPPER prices dropped off to 6c. delivered Connecticut, a new all-time low level, during the second week of February. The market weakness was attributed to lack of buying interest and the possibility of a British tariff, according to *Metal and Mineral Markets*. Copper producers are expected to get together for conference on methods to correct the unfavorable turn of events.

ZINC sales have been fair, with purchases mostly for prompt shipment. Prices for Prime Western Feb. 10 were about 2.80c., St. Louis. Sales of high-grade zinc were higher in January than for some time, and stocks were considerably reduced.

LEAD demand was off, buyers apparently feeling that an immediate upward movement of prices is not likely. The New York price of 3.75c. remained unchanged up to the middle of February.

TIN quotations weakened during the second week in February because of the reaction from the unsettled condition of the copper market. The price Feb. 10 was 21.40c., with a fair amount of business being done.

BERYLLIUM-COPPER is now being offered in wrought form as sheets, wire and rod, and because of its high strength and excellent conductivity is expected to have a good acceptance as an electrical construction material. The quotation on beryllium-copper 12.5 per cent master alloy ingot for castings is $6.35 per lb. for quantities.

BRASS ingot business was reported light in February. Prices on 85-5-5-5 ingot averaged 7.207c. per lb., and those on No. 1 yellow ingot averaged 5.881c. per lb. All buying of scrap was poor, and scrap prices dropped to new lows.

Standards and Specifications

A revised Simplified Practice Recommendation on Coated Abrasive Products has been submitted to industry for criticism and comment. If accepted, it will supplant R89-28. It reduces the number of types and sizes to 1949. Federal Specification No. 374 on Admiralty-Metal, Condenser, and Ferrule-Stock tubes, has been issued for criticism and comment, to supersede USGMS 374, if accepted. Simplified Practice Recommendation No. 62 on Metallic Cartridges has been reaffirmed.

The American Standard Symbols for Mechanics, Structural Engineering and Testing Materials has just been issued and copies are obtainable from the A.S.A. or A.S.M.E.

Revised Simplified Practice Recommendation R17-31 on Forged Tools is now available in printed form. A Federal Specification is proposed for Insect Screen Wire Cloth.

Campaign to Hire 1,000,000 Men

Committees in more than 7,000 cities went into action Feb. 15, representing the American Legion, American Federation of Labor, and Association of National Advertisers, backed by welfare, civic and business organizations, in what is described as the greatest mass campaign since the World War, to obtain jobs for 1,000,000 unemployed. Magazines and other publications with combined circulation of 35,000,000 and sixty prominent radio advertisers are cooperating in presenting reports of progress in the drive. The campaign itself has been supported and complemented by the campaign directed from the White House to bring hoarded money into circulation.

Weld Design Course

Representatives of General Electric Co. and other engineers came from all over the United States, Canada and Russia to take the new GE course in the design of welded structures. At the end of 1931, three months after the start, 61 had completed it, 27 of them engineers of other companies.

Meetings

British Industries Fair—Castle Bromwich, Birmingham; and White City and Olympia, London, England, Feb. 22-Mar. 5. Displays and exhibits will cover all sorts of equipment and machinery, both for industrial and domestic use.

American Management Association—Packaging, packing, and shipping exposition, Palmer House, Chicago, Ill., Mar. 7-12, 1932. W. J. Donald, managing director, Room 602, 225 West 64th St., Chicago, Ill., or 20 Vesey St., New York.

American Society of Bakery Engineers—Annual meeting, Edgewater Beach Hotel, Chicago, Mar. 14-17. Includes exhibits of bakery machinery. Victor E. Marx, secretary, 1541 Birchwood Ave., Chicago.

American Railway Engr'g Assn'n—Annual meeting, Palmer House, Chicago, Ill., Mar. 15-17. E. H. Fritch, secretary, 59 East Van Buren St., Chicago.

National Aircraft Show—Annual Exposition sponsored by Aeronautical Chamber of Commerce, Inc., Detroit Municipal Airport, April 2-10. Ray Cooper, show manager, 320 West Lafayette Blvd., Detroit.

Knitting Arts Exposition—28th annual show of textile machinery, Commercial Museum, Philadelphia, Pa. April 11-15.

American Oil Burner Ass'n—Annual meeting and exposition, Boston, Mass., April 11-15. Harry F. Tapp, secretary, 342 Madison Ave., New York City.

Electrochemical Society—Spring meeting, Baltimore, Md., April 21-23. Colin G. Fink, Secretary, Columbia University, New York City.

American Foundrymen's Ass'n—36th annual convention and exhibition, new Municipal Convention Hall, Philadelphia, Pa., May 2-6. Executive secretary, 222 West Adams St., Chicago.

American Society for Testing Materials—Annual meeting, Atlantic City, June 20-24. R. E. Hess, assistant secretary, 1315 Spruce St., Philadelphia, Pa.

National Machine Tool Builder's Ass'n—Third National Machine Tool Show, Cleveland (Ohio) Municipal Auditorium, Sept. 10-17. Boyd Fisher, general manager, 1415 Enquirer Bldg., 617 Vine St., Cincinnati, Ohio.

National Metal Congress & Exposition—174th Regiment Armory, Buffalo, N. Y., Oct. 3-7. Sponsored by A.S.S.T., with cooperation of A.S.M.E., Institute of Metals and Iron & Steel Divisions of A.I.M.E., A.W.S., and the Wire Association. W. H. Eisenman, 7016 Euclid Ave., Cleveland, Director.

Engineers and their Activities

A. J. Scaife

A. J. SCAIFE has been elected president of the Society of Automotive Engineers. Vice-presidents include: W. B. STOUT — Representing Aircraft Engineering; C. L. LAWRANCE —Representing Aircraft-Engine Engineering; A. J. POOLE—Representing Diesel-Engine Engineering; B. B. BACHMAN—Representing Motor-Truck and Motorcoach Engineering; D. G. Roos—Representing Passenger-Car Engineering; A. J. NEERKEN—Representing Passenger-Car-Body Engineering; J. E. PADGETT—Representing Production Engineering; A. S. MCARTHUR—Representing Transportation and Maintenance Engineering. Mr. Scaife is consulting field engineer for White Motor Co., Mr. Stout president of Stout Engineering Laboratories, Mr. Lawrance president and general manager of Lawrance Engrg. & Research Corp., Mr. Poole is with Bendix Aviation Corp., Mr. Bachman vice-president of the Engineering Division, Autocar Co., Mr. Roos chief engineer of Studebaker Corp., Mr. Neerken assistant chief engineer of Hupp Motor Car Corp., Mr. Padgett assistant vice-president and general manager of Spicer Mfg. Corp., and Mr. McArthur general superintendent of the Toronto Transportation Commission.

W. B. Stout

WILLIAM DAVID COOLIDGE, associate director, General Electric Research Laboratory, received the Washington Award administered by the Western Society of Engineers on recommendation of the four founder engineering societies, Feb. 24, at Chicago. Among the achievements for which this award is given to Dr. Coolidge are: ductile tungsten used for lamp filaments, wrought tungsten for contacts, the hot cathode X-ray tube and various types of X-ray generating equipment, the C-tube for submarine detection and signaling, and the cathode ray tube.

EVERITT J. COLE, director of Hilo Varnish Corp., 4260 Stewart near Flushing Ave., Brooklyn, N. Y., and formerly chief chemist until his appointment last November as industrial sales manager, has been elected secretary. He has contributed several articles on finishes to *Product Engineering.*

C. L. Lawrance

E. T. BARRON, metallurgist, and J. O. LEECH, manager, bureau of inspection and tests of the metallurgical department of Carnegie Steel Co., Pittsburgh, have been advanced to assistant metallurgical engineer. G. ELKINS KNABLE, metallurgist in the metallurgical department has been appointed manager, bureau of inspection and tests, in this department.

A. J. Poole

DR. J. G. DAVIDSON, formerly senior fellow on the research staff, Mellon Institute of Industrial Research, Pittsburgh, and more recently general sales manager of Carbide & Carbon Chemicals Corp., 30 E. 42d St., New York, N. Y., has been elected vice-president.

GERMAN C. DIEDRICHS, formerly designer and mechanical and aeronautical engineer of Metalclad Airship Corp., Detroit, has resigned. He was also formerly connected with Aircraft Development Corp., and the Detroit Aircraft Corp., both of Detroit.

H. J. FISCHBECK, chief metallurgist, Pratt & Whitney Aircraft Co., spoke recently on "Metallurgy in Aircraft Motor Construction" at a meeting of the New York chapter, A.S.S.T.

K. L. HANSEN, inventor of welders manufactured by Northwestern Mfg. Co., Milwaukee, has joined Harnischfeger Corp., Milwaukee, in a consulting capacity. Harnischfeger has recently acquired the arc-welding and electric motor line of Northwestern Mfg. Co., and will manufacture the products at its National Ave. plant.

R. W. HASTINGS, formerly divisional engineer with H. H. Franklin Mfg. Co., Syracuse, N. Y., has become engineer in charge of design of automotive equipment at the Holyoke (Mass.) works of Worthington Pump & Machinery Corp.

HERBERT J. HILLBORN, formerly designing engineer with Koehring Co., Milwaukee, has become factory representative in Northern Illinois and Iowa for Superior Steel Products Corp., Milwaukee.

MAJ. C. W. HOWARD, chief engineer of the Materiel Division, U. S. Army Air Corps, Wright Field, recently presented a resumé of the action taken by the Materiel Division on engineering problems before the annual engineering supply conference of visiting officers from all major Army air fields.

BENJAMIN JEROME has resigned from his position as quality engineer for H. H. Franklin Mfg. Co., Syracuse, N. Y. He had held this position for approximately two years, after having been connected for 22 years in executive engineering capacities with several leading automobile companies.

WILLIAM S. LEE, Charlotte, N. C., past president of the A.I.E.E., was elected president of the American Engineering Council at its annual meeting in Washington, Jan. 14-16. Mr. Lee is president of W. S. Lee Corp., vice-chairman of Duke Endowment, and consulting engineer of a number of industrial enterprises. He succeeds

CARL E. GRUNSKY of San Francisco, and will hold office for two years. L. B. STILLWELL and GEN. RICHARD C. MARSHALL, JR., New York, were chosen vice-presidents. FARLEY OSGOOD, of New York, was named treasurer to succeed DR. HARRISON E. HOWE, of Washington.

ROBERT E. MASTERS, consulting mechanical engineer, celebrated his 83rd birthday Dec. 25, 1931. He was the first man to apply the present type Washburn car wheels.

G. F. MCDOUGALL, consulting mechanical engineer of Portland, Ore., has been elected vice-president for the coming year of Oregon Technical Council consisting of representatives of all major branches of engineering in the state. The chief function of the Council this year will be to direct the engineers' relief organization recently formed.

BONIFACE A. MILLER, formerly metallurgist, Bartlett - Hayward Co., and American Hammered Piston Ring Co., Baltimore, has been made metallurgical engineer of James J. Lacey Co., Baltimore, Md.

MEAD F. MOORE, in charge of the engineering division of the Milwaukee plant, Nash Motors Co., Kenosha, Wis., from the time it was established in 1922 until it was consolidated with the main works in Kenosha, has been appointed chief engineer of the Nash works in Racine, Wis. He succeeds N. E. WAHLBERG, who was recently elected vice-president in charge of all Nash engineering.

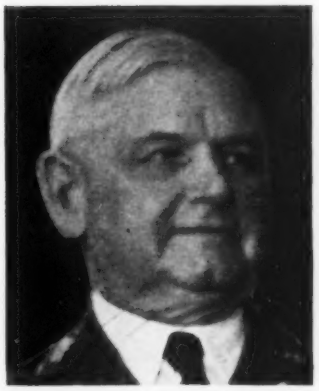
E. K. BARD has been appointed engineer by Four Wheel Drive Auto Co., Clintonville, Wis. Mr. Bard, a commercial artist and engineer, has been a member of the FWD engineering staff for the past three years. His new position will enable him to devote all of his time to the appearance phase of design as well as to offer a consulting service for customers on improving the appearance of their trucks. Color combinations, lettering layouts and special finishes will be directly under the supervision of Mr. Bard.

BRIG. GEN. SAMUEL MCROBERTS, O.R.C., prominent banker and during the World War in charge of contracting for all weapons and munitions used by the American forces, became a peace time "dollar-a-year" man Jan. 24 when he was sworn in as district chief of the New York Ordnance District, U. S. Army. He succeeds COL. JAMES L. Walsh, O.R.C., recently appointed executive vice-president of the Guardian Detroit Union group, Detroit, who has held the office since 1923. General McRoberts was chief of the procurement division with the direction of contracts of all ordnance material used by the U. S. forces during the War. His office furnishes manufacturers with the necessary information to develop special plants to facilitate promptly their change from peace to war manufacture and to prepare facilities to produce ordnance munitions promptly upon direction of a national emergency.

B. B. Bachman

D. G. Roos

E. K. Bard



Samuel McRoberts

ROBERT THEODORE PLATE has become research engineer with General Motors Research Corp., Detroit. He was previously assistant chief engineer of Wilcox-Rich Corp., also of Detroit.

W. S. PRITCHARD has become a development engineer for Doehler Die Casting Co., Toledo, Ohio.

JOHN D. RAUCH, formerly chief engineer of Ohio Power Shovel Co., Lima, Ohio, has been appointed consulting and research engineer.

W. A. ROSENBERGER has been made chief engineer of Pangborn Corp., Hagerstown, Md. He has specialized for 20 years in blast cleaning and dust collecting design problems.

FRANK H. RUSSELL, of Curtiss Aeroplane & Motor Co., Inc., has been elected president of Manufacturers' Aircraft Association. The association grants licenses under the 466 patents owned or controlled by its members. Other officers elected were: Vice-presidents, J. DON ALEXANDER, Alexander Industries, Inc.; EUGENE E. WILSON, Chance Vought Corp.; E. T. ASPLUNDH, Pitcairn Aircraft, Inc.; treasurer, CLAYTON J. BRUKNER, Waco Aircraft Co.; secretary, WALTER C. DAVIS, Davis Aircraft Corp.; general manager, S. S. BRADLEY.

W. E. SANDERS, chief metallurgist and plant engineer of Muncie Products Corp., Muncie, Ind., gave an illustrated lecture on research conducted on steel forgings at the last meeting of the A.S.S.T. chapter there.

JOHN SEAGREN, formerly engineer in the research department of Fairbanks, Morse & Co., Beloit, Wis., has become engineer in the development and experimental department, Atlas Imperial Diesel Engine Co., Oakland, Calif.

F. W. STEERE, formerly president of Steere Engineering Co., Detroit, Mich., has opened an office in the Bar Bldg., White Plains, N. Y., under the name of F. W. Steere Co., incorporated in Michigan, and is to take out a license from Autogiro Co. of America for the manufacture of "windmill" planes under the De Cierva patents. HERACLIO ALFARA will be in charge of engineering.

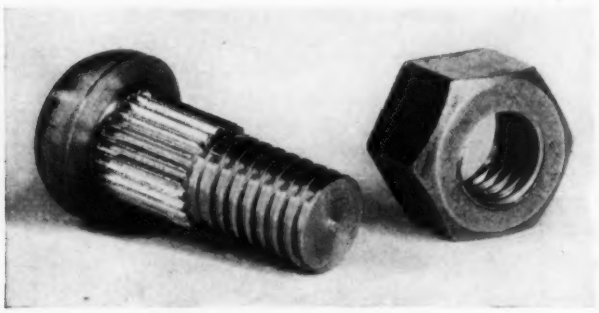
G. J. COMSTOCK, director of research of Firth Sterling Steel Co., McKeesport, Pa., spoke on "Cemented Tungsten and Tantalum Carbides" at the Jan. 21 meeting of the Hartford (Conn.) Engineers Club.

J. W. THOMAS, formerly vice-president and general manager of Firestone Tire & Rubber Co., Akron, Ohio, has become president to succeed H. S. FIRESTONE, who has been elected chairman of the board of directors. Mr. Thomas joined the company 24 years ago as a chemist in the engineering department, and has held the office of vice-president for the last 12 years.

MATERIALS AND PARTS

Dardelet "Rivet Bolts"

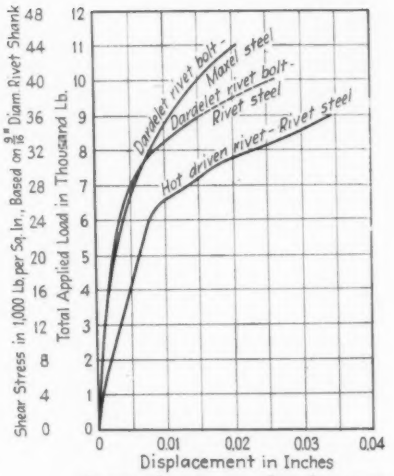
Fabrication of machine elements and process equipment with Dardelet "Rivet Bolts" instead of hot-driven rivets can be accomplished more cheaply and joints will be stiffer and stronger in shear and tension, it is claimed. Designed by the Dardelet Threadlock Corp., 120 Broadway, New York, N. Y., they are now in production by its licensees. On most work, the over-all cost of fabrication per rivet bolt is said to be approximately one-half the cost of a hot-driven rivet. This figue is arrived at because the rivet bolt need only be tapped into the hole and the nut drawn up, whereas with ordinary rivets it is necessary to heat the rivet and to use more labor in driving. Moreover, the rivet bolt can be used in places which are difficult to get at for riveting.



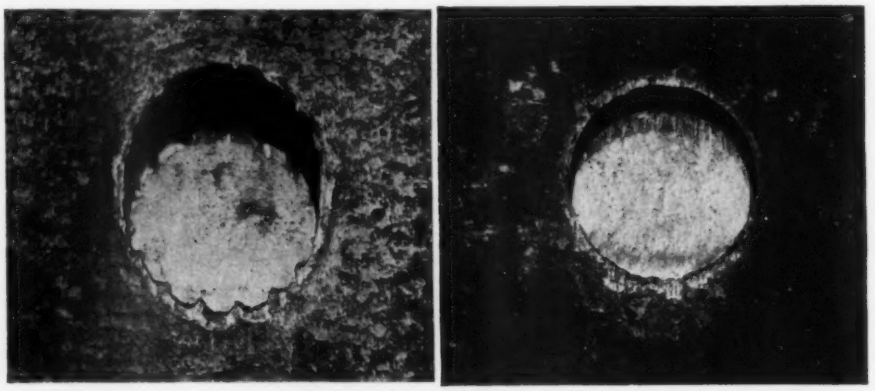
Unretouched photograph of Dardelet "Rivet Bolt"

The rivet bolt is seen to have a standard round head, a splined body approximately $\frac{1}{32}$ in. larger than the drilled rivet hole, and a shank threaded with the standard Dardelet thread to prevent backing off by the nut under severe vibration conditions. In even the largest sizes the device is driven into the hole with not more than a 4-lb. hammer. When the nut is tightened down, the splines resist turning of the bolt, so that more tension can be set up in the shank than will occur with shrinkage of a hot-driven rivet, and so that the parts held together will be under higher static friction to prevent slipping. Moreover, the oversize splines insure equal bearing around the bolt and prevent loosening of the Rivet Bolt in the hole. Other advantages are: the bolt may be made in a steel that has an ultimate strength of 80,000 lb. per sq.in. (higher than rivet steel); higher-strength steels can be used, often heat-treated; and the rivet bolt can be removed quickly and used again should disassembly of the machine or process equipment be required at any time.

Tests made at Columbia University indicate that lap joints assembled with rivet bolts are stiffer and also stronger in shear and tension than similar joints connected with structural hot-driven rivets. The curves representing the behavior of the rivet bolt connections, show no pronounced slip, but rather a gradually increasing rate of displacement with applied load, which may be due either to the high frictional resistance resulting from the tension produced by the nut or to the intimate contact of the splined body with the bolt holes or both. It may be noted that the load-displacement relations are practically the same for the Rivet Bolt connections whether the bolts were made of Maxel steel or structural rivet steel up to a shear stress of about 30,000 lb. per sq.in., when the structural rivet steel yield point was reached. The Maxel steel is stronger that structural rivet steel.


Shear Stress in 1,000 Lb. per Sq. In., Based on $\frac{9}{16}$" Diam Rivet Shank
Total Applied Load in Thousand Lb.
Displacement in Inches
Dardelet rivet bolt - Maxel steel
Dardelet rivet bolt - Rivet steel
Hot driven rivet - Rivet steel
0
0.01
0.02
0.03
0.04

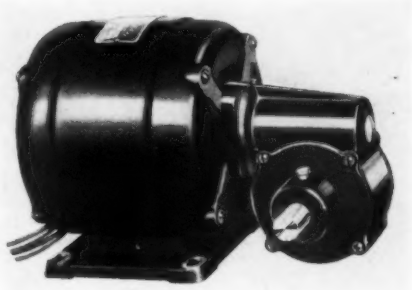
Composite curves showing tests on Dardelet "Rivet Bolts" and structural steel rivets. Note the lower displacement for the Rivet Bolts due to the greater static friction between the parts held together



Left—Unretouched photograph of sheared Dardelet "Rivet Bolt" and of surrounding plate after tension test on a lap joint. Right—View of sheared hot-driven rivet and surrounding plate

Bodine Ball-Bearing Motor with Speed Reducer

A line of fractional-horsepower motors with worm-gear speed reducers has been developed by the Bodine Electric Co., 2264 W. Ohio St., Chicago, Ill. These motors are built into the Type N-5 frame, which



is of three-piece construction. Ventilating ducts and the fan have been enlarged and the ratings increased.

Gear reductions of 10 to 1, 20 to 1, and 40 to 1 are available, which afford slow shaft speeds of 28, 43, 56, 86, 112, and 172 r.p.m. at standard motor speeds of 1,125 and 1,725 r.p.m. The speed reducer consists of a separable Nitralloy steel worm and an oversize Bakelite gear mounted in a grease-tight housing. Double ball bearings absorb the end thrust on the rotor shaft. The slow-speed shaft runs in leaded bronze bearings with wool-packed lubrication. These motors are rated from 1/20 to $\frac{1}{8}$ hp., and they are they are available for a.c. and d.c.

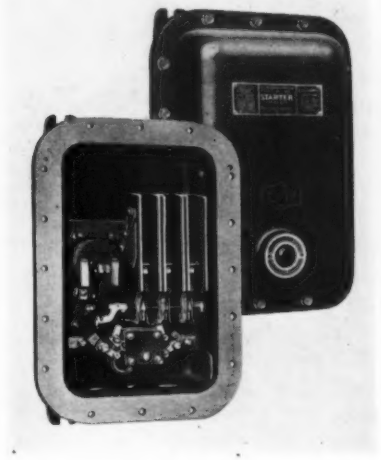
Northern XE Series Rotary Pumps

A larger series of Nitralloy steel gear pumps is announced by the Northern Pump Co., Minneapolis, Minn. Similar construction is used as for Series XA pumps, described on page 237, Vol. 2, and for a Series XD pumps, described on page 43, this volume, but the capacity is larger. At 50 lb. per sq.in. and 1,000 r.p.m. the delivery is 11.6 g.p.m. for size 10XE and 35 g.p.m. for size 30XE, using oil of 300 sec. Saybolt viscosity. Rated pressures are up to 1,000 lb. per sq. inch.

Two types of bearing construction are available. For handling liquids having little or no lubricating values, Nitralloy shafts turn directly in Nitralloy pump and bearing plates. When lubricating oil is pumped, roller bearings can be used in the steel pump body. Either spur or helical Nitralloy gears can be supplied. The plates that comprise the pump body are held together by four dowel bolts.

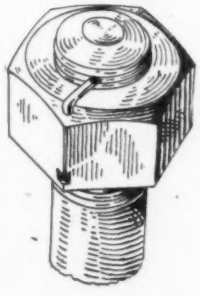
Cutler-Hammer Explosion-Proof Starters

Cutler-Hammer, Inc., 296 N. 12th St., Milwaukee, Wis., has announced an explosion-proof, across-the-line automatic starter of the a.c. type. This starter meets the specifications of the Underwriters' Laboratories



for Class 1, Group D hazardous locations. It is of the air break type, and there is no oil tank. The heavy cast-iron, explosion proof inclosure is designed to prevent an internal explosion from igniting the surrounding explosive atmosphere. The construction consists of a standard three-pole magnetic contactor with thermal overload relays. These starters are designed in three sizes to take care of motors up to 30 hp., 220 volts, and 50 hp., 440 or 550 volts.

"General" Automatic Locknut

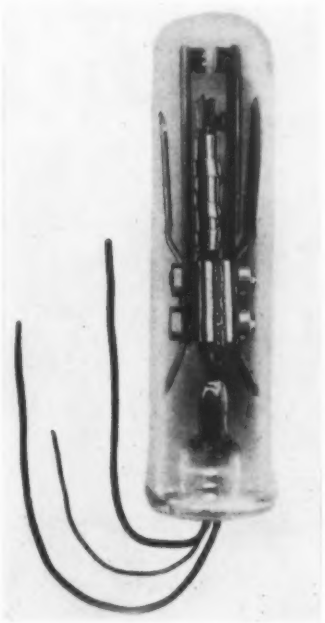


Automatic locknuts, which are said to be self-locking at any point and can be applied wherever screw threads are used, are announced by the General Automatic Lock Nut Corporation, 1775 Broadway, New York, N. Y. The nuts are applied like any ordinary nut, but when tightening is discontinued the nut remains secure against backing off, it is said, and vibration only locks it tighter. Only a wrench can loosen the nut. To unlock, it is merely necessary to turn the nut backward with the wrench $\frac{1}{4}$ turn. This automatically unlocks the pin and permits the nut to be removed.

"Edison Birka" Temperature Regulator

The "Edison Birka" temperature regulator announced by Thomas A. Edison, Inc., Orange, N. J., is a thermostatic circuit making and breaking device operated by the surrounding temperature. The contact points operate within a hermetically sealed glass tube, which may be exhausted to a high vacuum or filled with an inert gas for better thermal conductivity. This feature minimizes arcing and protects the regulator against corrosion and dirt. The regulator may be used also as a thermostatic relay switch in conjunction with a sensitive thermostatic determinator, which in turn is designed to carry only a very small current.

The regulator is a self-contained



unit, and requires no external actuating mechanism. It may be placed in any position from the horizontal to the vertical. The relay illustrated is placed remote from the temperature being controlled. It is operated by means of a suitable temperature

determining device. The Type D regulator, not shown, is subjected directly to the temperature to be controlled. Applications of the relay regulator are numerous, and typical examples include grills and other cooking apparatus for restaurant use, baking ovens, technical and industrial ovens, oil burner controls, refrigerator controls and unit heaters.

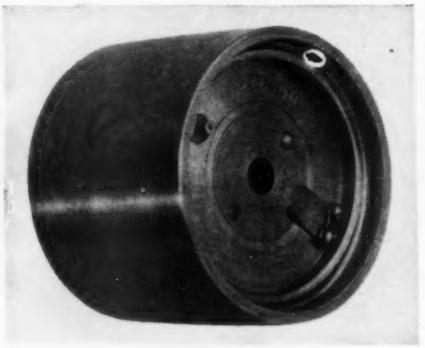
Sunlight Series 400 Frame Induction Motors

A Series 400 frame motor in fractional-horsepower sizes has been developed by the Sunlight Electrical Mfg. Co., Warren, Ohio. The sizes are $\frac{1}{8}$, $\frac{1}{6}$, $\frac{1}{4}$ and $\frac{1}{3}$ hp., and the motor is made in the induction type only for 110 volt, 60 cycles, and is regularly

furnished with a $\frac{1}{2}$-in. shaft. When operated on its normal voltage, the motor will start a load slightly in excess of twice the full load torque. A maximum temperature rise of 40 deg. C. is designed for constant duty at full load conditions. The motor is lower in price than the DeLuxe Series motors, but has standard features and comes equipped with a 10-ft. all-rubber cord and plug.

Ramsey-Pulvis Automatic Starting Clutch

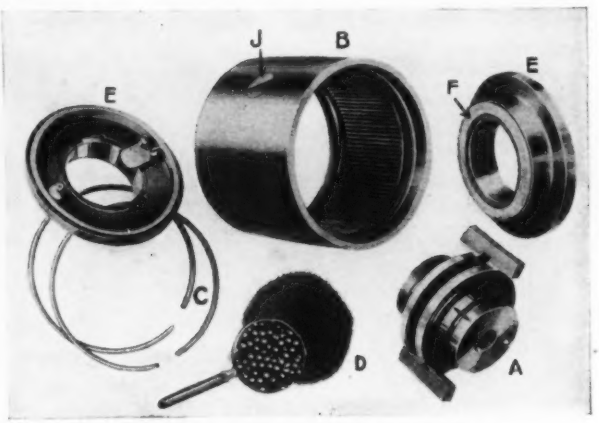
An automatic starting clutch, which permits the driving motor or other prime mover to come up to speed without load, gives protection against shock, and eliminates the transmission of working strains, is now being offered by the Ramsey Chain Co., Albany, N. Y. This company has exclusive control of the manufacture and sale of the device in the United States. The Pulvis principle consists of the gradual transmission of power by centrifugally increasing density of hardened steel shot against driving and driven elements of the clutch. Applications are different than those to which industrial users are accustomed. The clutch can be made as



Ramsey-Pulvis Clutch

part of the driving member of industrial drives, such as silent or roller chain, flat belt, multiple V-belt and all gear types, as well as a coupling on direct-connected drives. In the photograph showing the parts of the Pulvis clutch, the rotor *A* is the driving member. It is mounted with a key and setscrew on the motor or prime mover shaft. This rotor is in effect a two-bladed paddle wheel. The shell *B* is the driven member, and with the two end plates *E*, it forms a complete closure around the rotor. The end plates are held by the snap rings *C*. The inner surface of the shell is serrated or grooved axially to provide a foothold for the shot. Packing rings *F* seal the housing assembly around the rotor. Steel shot *D* constitute the power transmitting medium between the driving rotor and driven housing. The shot is graphite coated for atmospheric protection and self-lubrication. This shot is introduced in the required quantity through the shell hole sealed with filling plug *J*. The same size of shot is used in all sizes of clutches.

Under centrifugal force, the shot within the clutch piles up in layers on the serrated surface of shell *B*, and piles of the shot also build up against the front of the wings. Having sufficient centrifugal force, the shot assumes the characteristics of a solid mass and effects a metallic connection between the wings and shell to hold the driven and driving elements of the clutch at the same speed. Any capacity up to 400 hp., 200 r.p.m. can be handled by a clutch of the proper size. Bulletin No. 132 describes the device completely.



Components of the Ramsey-Pulvis Clutch

Unyte Urea-Formaldehyde Plastic Molding Compound

Plastic molding compound of the urea-formaldehyde type in either granulated or sheeted stock is now being placed on the market by the Unyte Corporation, Grasselli, N. J. This material is offered with controlled flow, rapid cure, stability during storage, and in shades that are fast to light. The corporation was formed to acquire the patent rights and processes relating to the field of urea resins from the I. G. Farbenindustrie, Frankfurt am Main, Germany, and the Ellis-Foster Co. and Carleton Ellis, of Montclair, N. J.

Harsh Resilient-Seated Ball Bearings

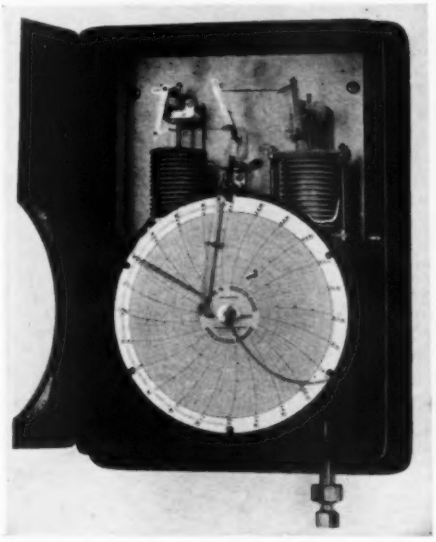
A ball-bearing device principally for use in wood and metal furniture drawers has been developed by Robinson H. Harsh, 225 Emerson St., N. W., Washington, D. C. This device absorbs the shrinking and swelling of wood to make wooden drawers slide without usual sticking, while in metal furniture it gives easy sliding action and also softness and silence. A typical use is on the metal drawers of gas ranges to eliminate the

unpleasant noise of the metal drawers sliding on bare metal runways. Application of the bearing in most cases will be about as follows: three bearings on each side to carry the drawer; one bearing in each of the upper rear corners to resist the leverage of the drawer as it is pulled out; one bearing in each of the rear sides of the drawer to prevent angle binding as it moves in and out, and one bearing in each of the forward sides of the drawer encasement to avoid side scraping of the drawer as it runs in and out. The bearing carries a $\frac{3}{8}$-in. bronze ball. The resilient casing, including the seat, is of high-carbon steel, hardened and tempered.

Bristol Recording Absolute-Pressure Gage

A direct-reading, single-pen, absolute-pressure gage of the recording type has been developed by The Bristol Co., Waterbury, Conn. The use of high vacuum is an important factor in many production processes. This instrument eliminates the possibility of confusion or delay resulting from applying barometric corrections to vacuum readings. Such an instrument gives important information for purposes of control in connection with the operation of turbo condensors, vacuum pans in sugar and salt drying, vacuum oil stills, vacuum packing and sealing of foods and other similar items in cans, vacuum retorts in chemical plants, the manufacture of gaseous-type vacuum tubes.

The instrument can be furnished for ranges as low as 0 to 50 mm. head of mercury pressure absolute or



equivalent. The actuating mechanism consists of two extremely sensitive diaphragm elements. One is connected to the vacuum line, and the other is directly affected by barometric pressure variations. The resulting movements of these two elements are transmitted by a differential transmitting linkage to a single per arm.

Dole Universal All-Tube Coupling

A compression coupling, which will fit seamed or seamless tubing of steel, aluminum, brass or copper, has been developed by The Dole Valve Co., 1913-33 Carroll Ave., Chicago, Ill. No soldering, flaring or separate sleeves are required in this coupling. As the coupling compresses, the small end of the threaded sleeve screw presses onto the tubing wall, thus filling the seam in a seamed tubing. The ball part of the threaded sleeve

screw presses against the funnel shaped inside wall of the coupling body forming a ball joint or seal. The sleeve and compression screw are united with solder, which breaks during compression, leaving the sleeve permanently on the tubing and providing a lead lubricated bearing for the compression screw. As the compression screw continues to be tightened, the end of the tubing is forced against the V shoulder in the coupling body, completing another independent joint. Another compression on the tubing is made at the point of the bearing of the compression screw on the sleeve, this causing the small tapered end of the sleeve to turn up against the inner wall of the compression screw, locking it against accidental separation.

Ohmite Vitreous-Enameled Resistors

Several additional resistance values have been included in the line of vitreous-enameled resistors manufactured by the Ohmite Mfg. Co., 636 N. Albany Ave., Chicago, Ill. These rheostats were formerly made in a range of values from 2 to 10,000 ohms, but this has now been increased to include values from 1 to 35,000 ohms. The units are only $2\frac{1}{4}$ in. in diameter and less than $\frac{1}{2}$ in. thick, but

their ratings are 50 watts. The 1-ohm unit has a current carrying capacity of 7 amp. without overloading.

The resistor employs a porcelain base and horseshoe-shaped porcelain core to support the winding. The entire unit, with the exception of the surface on which the contact arm rides, is vitreous enameled. The fine wire employed on high resistances is held in a solid foundation by the porcelain and is prevented from moving under the action of the contact arm by the vitreous enamel.

Bruning Electric Erasing Machine

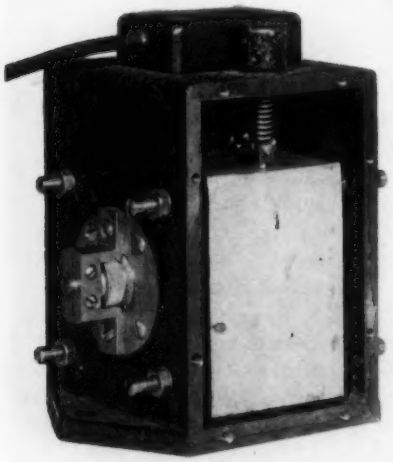
An electric erasing machine that can be held between the fingers to give accurate control has been developed by the Charles Bruning Co., Inc., 102 Reade St., New York, N. Y. The illustration shows the ease with which the instrument is manipulated. An 110-volt, 25-watt universal motor is employed for the device, which

weighs 14 oz. and is 5 in. long. A cord 6 ft. long with plug is included. Several grades of erasers for work on tracing cloth and paper are available for use with the instrument.

General Electric Electric Vibration Detector

For measurements of vibration in machinery to thousandths of an inch the General Electric Co., Schenectady, N. Y., has developed an electric vibration detector. This instrument is bolted to the machine under investigation. Within its case, as shown, there is suspended a block of lead. Two tension springs at the top and four springs on each side of the weight hold it in position. The outside shell of the detector vibrates with the same period as the machine to which it is attached, but the lead weight remains fixed in space because of its mass and low natural frequency.

In the lead weight are imbedded two coils, on opposite sides. In front of each coil is an adjustable piece of magnetic steel fastened to the outer shell. The coils in the weight are energized by 500-cycle a.c., and the air gaps between the coils and pieces



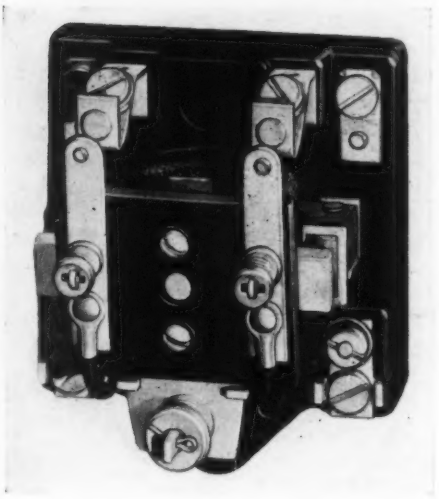
of magnetic steel are adjusted so that the two coils are electrically balanced.

Vibrations of the machinery to which the detector is attached cause a swaying of the outer shell of the instrument, therefore varying the distances between the coils and the magnetic pieces. These differences cause a variation in the flow of the 500-cycle current. These differences are translated into thousandths of an inch in vibration readings by indicating or recording instruments.

Square D Class 8511 Types H and K Contactors

The Industrial Controller Div., Square D Co., 710 S. Third St., Milwaukee, Wis., has offered two sizes of the Class 8511 magnetic contactor, designated as Types H and K. These sizes are rated from 3 to 15 amp. for non-inductive load or the fractional horsepower ratings. The features include laminated magnet frames, floating armatures to insure quiet operation, silver-to-silver contacts, porcelain bases, and capacity for voltages up to 220 for Type H and 440 for Type K.

These contactors are built in a variety of combinations: single and double pole, single and double throw, circuit opening and closing, two- or three-wire control, and three-wire



thermostat control. Applications are temperature regulators, oil burners, stokers, electric ranges, clocks, signal and lighting systems and small motors.

New Books and Publications

HYDRAULIC DRIVES IN MACHINE TOOLS. *By E. Preger, Baurat Dipl.-Ing. 88 pages, 5½x8 in. 183 illustrations. Cloth cover. Published by the VDI-Verlag, Berlin, in German. Price, R.M. 8.00.*

THIS work, perhaps the first of its kind, is a systematic presentation of the subject of hydraulic drives applied to machine tools. The first 25 pages are devoted to fundamental principles, a description of the different types of hydraulic pumps for machine operation, hydraulic motors for rotational motion, construction of hydraulic cylinders, piping, relief valves, and operating valves.

The balance of the book contains 183 illustrations of hydraulic applications. Each of the illustrations, most of which are diagrammatic, carries with it a comprehensive caption and explanation. Although most of the information pertains particularly to machine tools, the same principles of operation will apply to any similarly operated machine.

THE CONQUEST OF SPACE. *By David Lasser. 271 pages, 8x5¾ in. Cloth-board covers. Indexed. Published by the Penguin Press, New York, N. Y. Price $3.*

AS ONE reads this book, which is written in an easy style, he is impressed with a feeling that wonders are to be accomplished in the development of craft that will travel great distances at unheard-of speeds. But from an engineering standpoint the space rocket is now in as elementary form as was the first airplane conceived a century ago. There are yet to be developed light, powerful fuels for driving it, and light, strong metals for its construction. Rockets for long-distance bombing are already in sight, but there is yet much pioneer engineering to be done before passenger rockets fly between the continents. The book, however, is an excellent engineering inspiration.

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MOTORS. The Bodine Electric Co., Oakley Blvd. & Ohio St., Chicago, Ill., has issued Bulletin No. 1013 on electric governor controlled constant-speed universal motors with and without integral gear reducers.

NITRIDING STEEL. The Electro Metallurgical Co., Unit of Union Carbide & Carbon Corp., 30 E. 42d St., New York, N. Y., has issued Bulletin No. CV 1 entitled "Chrome - Vanadium Nitriding Steel." Its physical properties, depth of case, and advantages are listed.

ROLLER BEARINGS. The Tyson Roller Bearing Corp., Massillon, Ohio, has published the second edition of an Engineering Manual, which is available to production, operating and design executives, engineers and superintendents. It is a 26-page book, file size, loose-leaf, containing essential information on the application of Tyson cageless tapered roller bearings.

ROLLER CHAINS AND SPROCKETS. The Chain Belt Co., Milwaukee, Wis., has issued Catalog No. 440 on "Rex Roller Chains and Sprockets." This catalog and engineering data book contains prices, weights and information on the design and application of roller chains, block chains, leaf chains and cut tooth sprockets. The catalog has an exceptionally large section on engineering data and also information on types and applications.